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YOUNG'S PRACTICE OF UROLOGY

BASED ON A STUDY OF 12,500 CASES

By

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WITH OVER 1000 ILLUSTRATIONS, 20 BEING COLOR PLATES

by

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VOLUME II

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PRACTICE OF UROLOGY

CHAPTER IX

MALFORMATIONS AND ABNORMALITIES OF THE UROGENITAL TRACT

KIDNEY

A. Development of the Kidney and Ureter

The permanent kidney in man is preceded by the development of two earlier excretory organs, the pronephros and the mesonephros. Of these, the pronephros is the first to develop; it is always rudimentary and degeneration sets in and is completed early. The mesonephros makes its appearance shortly after that of the pronephros, attains a large size, and is an important organ during embryonic life. The few remnants of it which remain enter into the formation of the genital apparatus. Before the mesonephros has attained its full development the metanephros or permanent kidney makes its appearance and becomes a functional organ while the mesonephros is undergoing degeneration.

In the early embryonic stages the mesoderm lying on either side of the neural tube undergoes segmentation, giving rise to the primitive somites of the embryo. Each somite is connected to the unsegmented mesoderm lying lateral to it by a stalk of mesodermal cells called the intermediate cell mass. It is from this intermediate cell mass that the tubules of the pronephros and, later, those of the mesonephros and metanephros have their origin.

I. **Pronephros.**—The earliest pronephric tubules are seen in embryos of about 9 to 10 pairs of somites (Felix[14]). They arise from the dorsal surface of the intermediate cell mass, run a short course obliquely to the ectoderm, and then bend caudally. The duct of one becomes united to the one below it, and thus a continuous duct is formed, lying below the ectoderm and extending downward into the caudal portion of the embryo. The tubules of the pronephros are extremely short lived, for those of the anterior end of the body have already undergone complete degeneration while those further caudally are still forming. In between the two extremes are tubules in various stages of degeneration and formation.

A model of the pronephros of a human embryo of 24 pairs of somites (greatest length 2.4 mm.) is shown in Fig. 483. The stage is one in which the pronephros can be said to have attained its most complete development in man. In the upper part of the model are seen the remnants of two degenerating pronephric tubules. The third and fourth are more complete. Each of these consists of a rounded blind end, known as the "pronephric chamber," which corresponds to the glomerular swelling of the adult kidney tubule. In some of the lower forms a glomerulus is actually formed, but in man no indication of it is present. The tubules are seen crossing obliquely toward the ectoderm to become the narrower "pronephric collecting tubules." These fuse together, and the "primary excretory duct" thus formed continues into the caudal portion of the embryo. Pronephric chambers

5, 6, and 7 may be said to be fully formed. In addition to the above, each possesses a "nephrostome," a rudimentary funnel-shaped opening from the cœlom which joins with the pronephric chamber. The relations of the parts of the pronephros as seen in cross-section are shown in Fig. 484.

Caudal to the pronephric tubules shown in Fig. 483 are seen developing mesonephric tubules, the so-called "mesonephric vesicles." Those immediately below

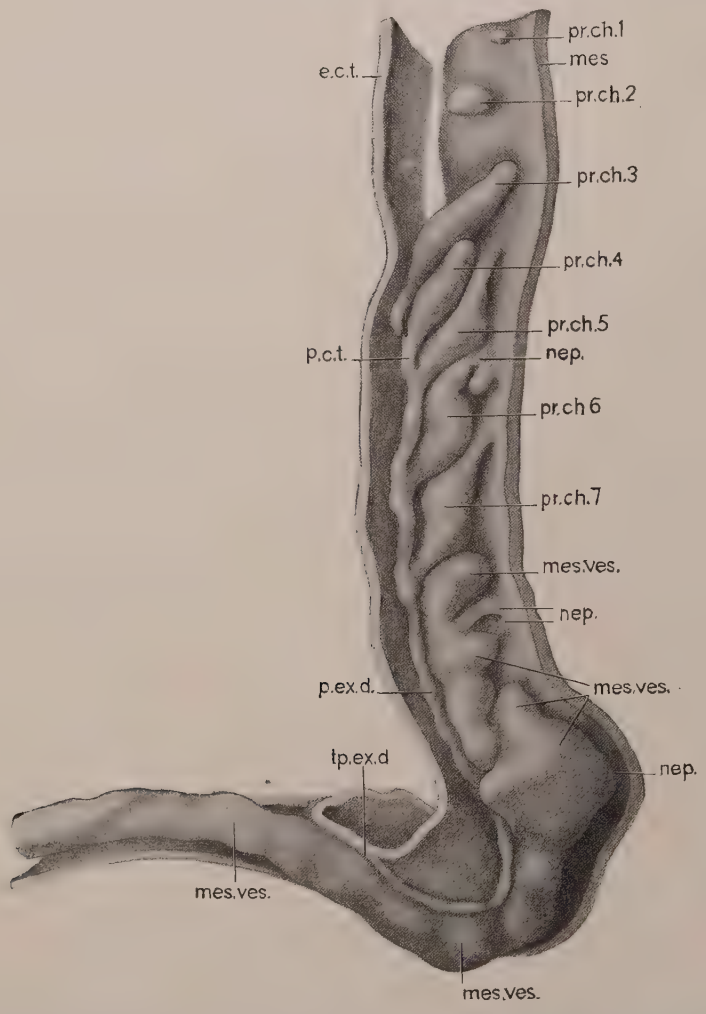

Fig. 483.—Model of the pronephros of a human embryo of 24 pairs of somites (greatest length 2.4 mm.). View from medial surface. *e.c.t.*, Ectoderm; *p.c.t.*, pronephric collecting tubule; *p.ex.d.*, primary excretory duct; *tp.ex.d.*, termination of primary excretory duct; *mes.ves.*, mesonephric vesicle; *pr.ch.*, pronephric chamber; *mes.*, mesoderm; *nep.*, nephrostome. After Johnson.[22]

the pronephros show a mixture of parts of both pronephric and mesonephric elements.

The pronephros has a most brief existence. According to Felix,[14] its time of complete disappearance is placed at a stage of 4.9 mm. crown-rump length. Its development and degeneration are completed, therefore, approximately between the third and fourth weeks of embryonic life.

II. **Mesonephros.**—The mesonephros or Wolffian body makes its appearance shortly after that of the pronephros, and for a time both structures coexist in the embryo. While the pronephros develops from the more cephalic segments, the mesonephros arises from the middle ones, leaving the caudal ones for the formation of the metanephros. The mesonephric vesicles likewise develop from the intermediate cell mass, which in the caudal region of the embryo is converted into a large continuous cord of cells, the "nephrogenic cord." From this cord mesonephric vesicles are formed by segmentation. Some of these are already formed in the embryo of 2.4 mm. (Fig. 483), others, more caudally situated, are in the process of formation.

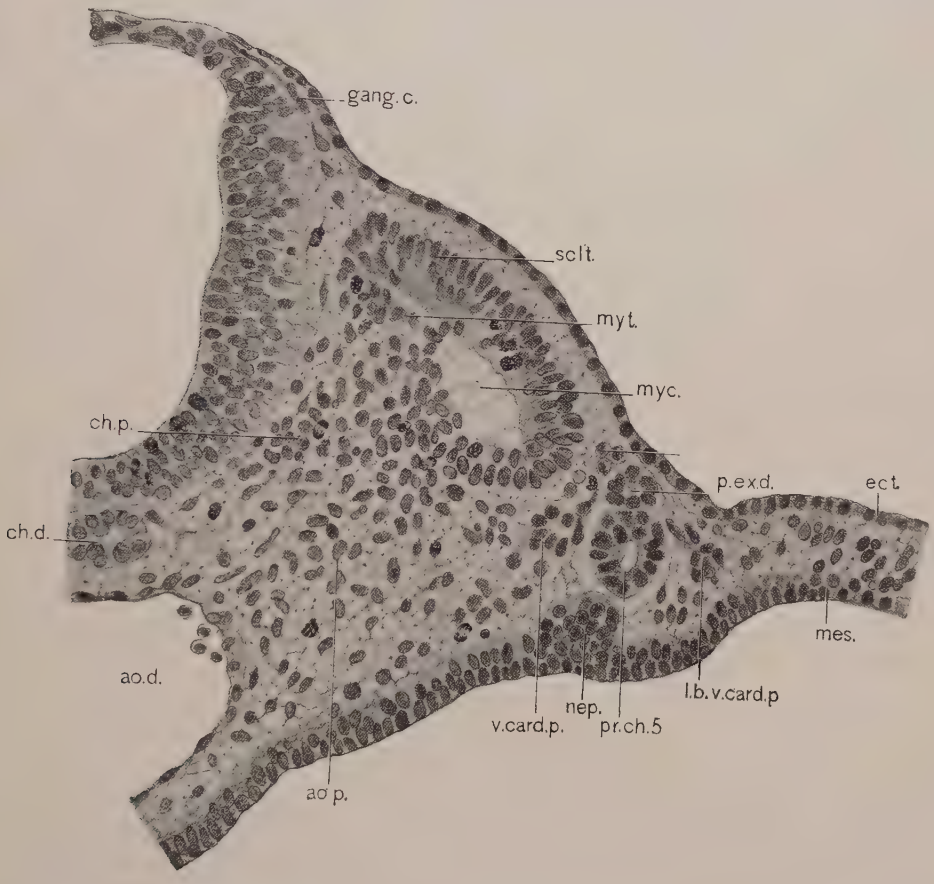

Fig. 484.—Section through the fifth pronephric chamber shown in Fig. 483. After Johnson.[22]

A "mesonephric tubule" grows outward from the mesonephric vesicle and joins with the primary excretory duct as shown in Fig. 485. The latter structure, therefore, serves as the excretory duct of both pronephros and mesonephros. The mesonephric vesicle becomes converted into a mesonephric corpuscle through the invagination of its medial wall by a tuft of blood-vessels, the glomerulus. The mesonephric tubules lengthen and become greatly convoluted; the primary excretory duct continues its growth caudally until it reaches the cloaca, with which it unites.

For a short time mesonephric tubules are added to both cephalic and caudal ends of the mesonephros. Soon, however, those placed anteriorly undergo degeneration, while the formation of new ones goes on rapidly caudally. They no longer observe a true segmental arrangement, several being formed within the same body segment from remnants of the nephrogenic cord. Whereas in an embryo of 5.3 mm. the 32 to 34 pairs of mesonephric tubules are found in the region between the sixth cervical and second lumbar segments, the 26 pairs of tubules in an embryo of 21 mm. lie between the first and third lumbar segments (Felix). This relative shortening of the mesonephros is produced only in small measure by a compression of the mesonephric tubules; its explanation is found rather in the fact that the

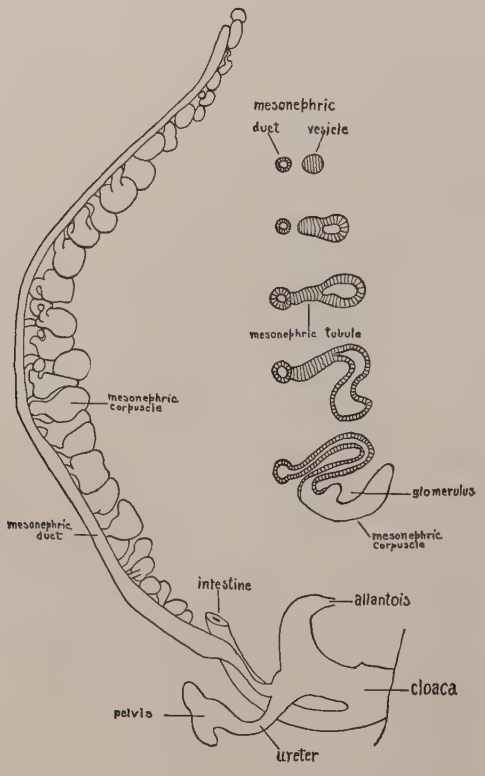

Fig. 485.—Mesonephros of a human embryo of 9.5 mm. After Felix.

more cephalic tubules undergo degeneration. Felix estimates that a total of 83 pairs of mesonephric tubules are formed, of which 57 are lost during the "first period of degeneration" (to the 21 mm. stage). During the second period of degeneration the process is slower. The mesonephric tubules are composed of a secretory and a collecting or excretory portion. The secretory portion, with its glomerulus, undergoes complete degeneration; a certain number of the collecting tubules remain to form portions of the sex organs. Of those collecting tubules remaining, a cephalic and a caudal group are to be recognized. The cephalic group consists of 5 to 12 tubules and is termed the "epigenitalis." In close relation to this portion of the mesonephros has been developing the sex gland. A union between the sex organ and the epigenitalis takes place in embryos of about 60 mm.

In the male the union takes place at the rete testis. The collecting tubules of the epigenitalis become the ductuli efferentia. These empty into the single mesonephric or Wolffian duct, the proximal portion of which becomes the epididymis, the distal portion, the vas deferens and the ejaculatory duct.

In the female a similar union takes place between the rete ovaris and the collecting tubules of the epigenitalis. Here the epigenitalis with a portion of the mesonephric duct becomes cut off and remains as the epoöphoron, while the remnant of the distal portion of the mesonephric duct forms Gärtner's canal.

The caudal group of mesonephric tubules known as the paragenitalis does not play so important a part in the formation of the sex organs. Small remnants

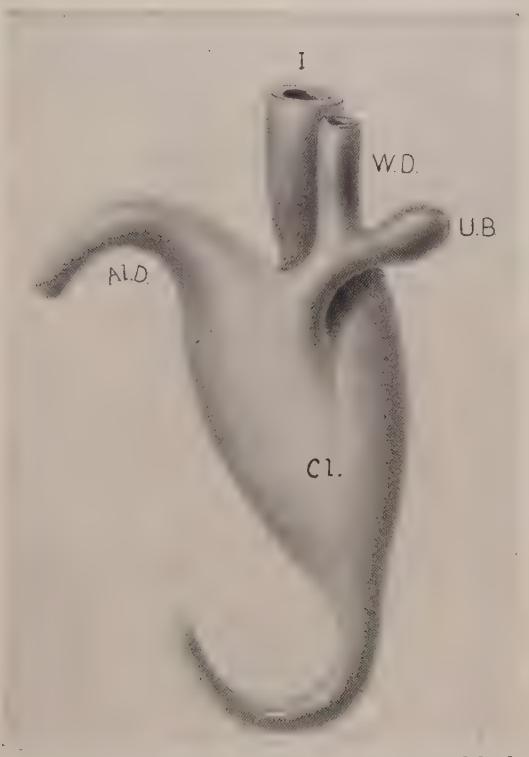

Fig. 486.—Model of the cloaca of a 6.5 mm. embryo. *U. B.*, ureteral bud; *W.D.*, Wolffian duct; *Al.D.*, allantoic duct; *Cl.*, cloaca; *I.*, intestine. After Keibel.

remain which, in the male, give rise to the paradidymis (organ of Giraldes) and an occasional ductus aberrans of Haller. Corresponding to the paradidymis in the female is the paroöphoron.

III. **Metanephros.**—The metanephric tubules, like those of the mesonephros, are made up of two portions, the collecting and the secretory. The former are derived from the primary excretory duct, the latter from the caudal portion of the nephrogenic cord. We have already shown how the primary excretory duct is formed from the union of the pronephric tubules, and how this duct grows downward into the caudal portion of the embryo to join with the cloaca. With the disappearance of the pronephros the primary excretory duct becomes the main excretory duct of the mesonephros. It is from the caudal end of this duct that the collecting

system of tubules of the kidney (ureter, pelvis, calices, and collecting tubules) has its origin.

The first appearance of the kidney is seen in embryos of 5 to 6 mm. in length as a slight swelling of the caudal end of the mesonephric duct. Soon it takes the form of a knob-like evagination on the dorsal surface of the duct (Fig. 486). As

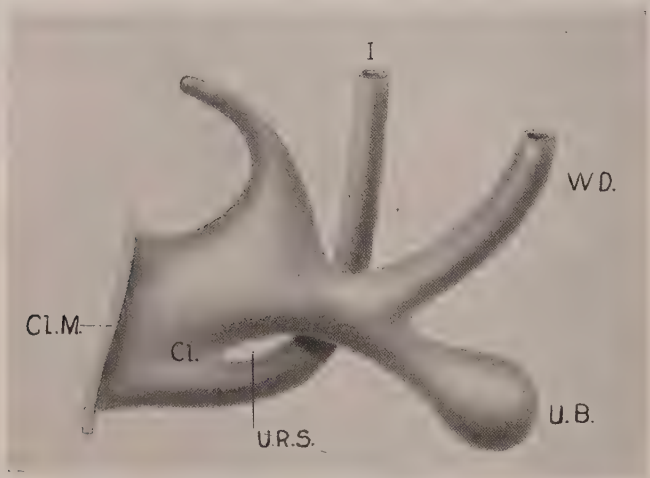

Fig. 487.—Model of the cloaca of a 7 mm. human embryo. *Cl.M.*, cloacal membrane; *U.R.S.*, urorectal septum; *W.D.*, Wolffian duct; *U.B.*, ureteral bud; *I.*, intestine. After Felix.

it grows in length the distal end becomes expanded (Fig. 487), giving rise to the renal pelvis, while the more constricted portion is destined to become the ureter. The primitive renal pelvis soon elongates and in Fig. 488 is seen to be dividing into two portions. These two divisions are recognized by Felix as the first of the

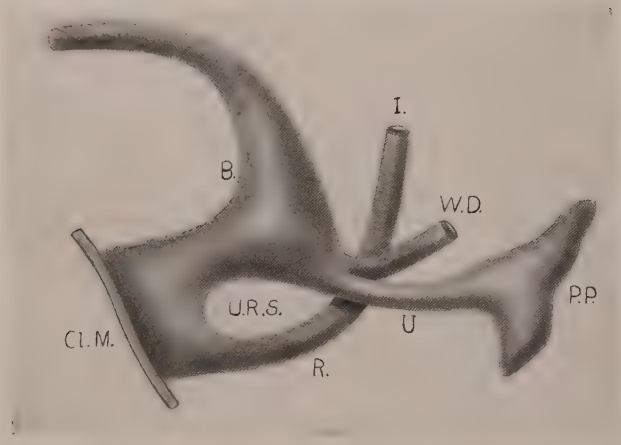

Fig. 488.—Model of the developing kidney of an embryo of 11.5 mm. The caudal and cranial pole tubules are growing out from the primitive pelvis, *P.P.* After Keibel.

collecting tubules, and he terms them the "cranial" and "caudal pole tubules." Later from the middle of the renal pelvis two other buds grow out, one dorsally and one ventrally. These four constitute the collecting tubules of the first order. Each of these divides to form from two to four collecting tubules of the second order, and these into tubules of the third order, and so on. The number of tubules

rapidly increases in this manner, one generation succeeding another, until tubules of the eleventh to thirteenth order have been formed. This point is reached in the fifth month of fetal life, after which time there is normally a partial reduction

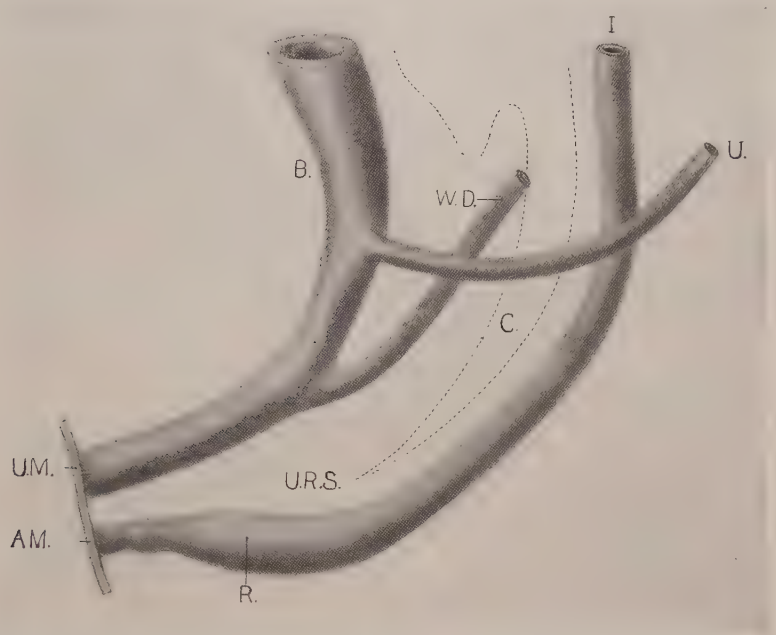

Fig. 489.—Model showing the complete separation of the ureter and Wolffian duct and the shifting of their orifices. Embryo of 25 mm. *B.*, bladder; *U.M.*, urogenital membrane; *A.M.*, anal membrane; *C.*, cœlom; *U.*, ureter. After Keibel.

in the number of collecting tubules. The developing ureteric tree is shown in Figs. 490 and 491.

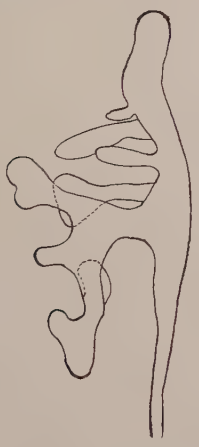

Fig. 490.—Model showing the development of the collecting tubules. Embryo of 12.5 mm. After Felix.

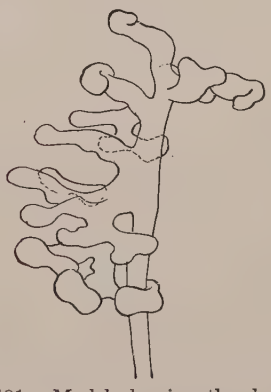

Fig. 491.—Model showing the development of the collecting tubules. Embryo of 19.4 mm. After Felix.

The ureteral bud develops on the lateral side of the terminal portion of the nephrogenic cord. The cells of this tissue soon arrange themselves in the form of a cap (metanephrogenic) which surrounds the outer circumference of the ureteral

bud. This tissue becomes condensed and is readily distinguished from the surrounding looser mesenchyme. With the formation of the collecting tubules of the first order the metanephrogenic cap is broken up and its portions form similar caps for each new tubule. This process continues with each succeeding generation, for as each tubule buds off from the parent tubule it carries with it a portion of the metanephrogenic tissue which encompasses it to form a new metanephrogenic cap. Beginning in embryos of 13 to 19 mm., however, a portion of the metanephrogenic cap is cut off from the rest, and its cells become arranged in the form of a hollow sphere (Fig. 492), the metanephric vesicle. From the upper part of this vesicle a tubule is formed which early unites with the adjacent collecting tubule. The lower end of the vesicle becomes flattened and transformed into the cup-shaped Bowman's capsule. Into the concavity of this structure blood capillaries grow and give rise to the glomerulus. The further development of the uriniferous tubule consists largely in growth changes. As the tubule grows in length it becomes contorted and gives rise to the various portions and loops found in the adult kidney. For a detailed account of this subject the reader is referred to the works of Huber,[20] Hauch,[17] Felix,[14] and others.

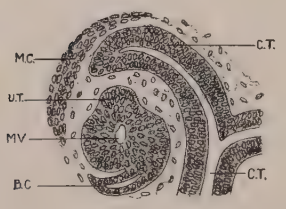

Fig. 492.—Portion of section of kidney of an embryo of 23 mm. showing metanephric vesicle cut off from metanephrogenic cap and anlage of kidney tubule and Bowman's capsule: *M.C.*, metanephrogenic cap; *C.T.*, collecting tubule; *U.T.*, uriniferous tubule; *M.V.*, metanephric vesicle; *B.C.*, Bowman's capsule.

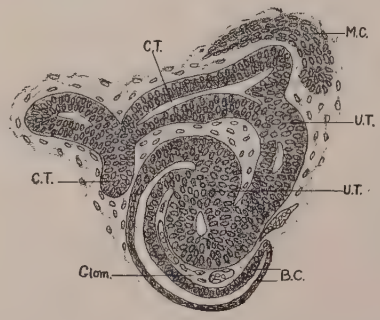

Fig. 493.—From the same kidney shown in Fig. 492, showing union of uriniferous tubule and collecting tubule, and further development of renal corpuscle.

Several new and interesting points concerning the early development of the uriniferous tubule have recently been described by Rienhoff,* whose careful observations have been based upon the growth of nephrogenic tissue in tissue cultures. He shows that the developing collecting and convoluted tubules are entirely surrounded by a continuous sheet of endothelial cells. The convoluted tubules are developed *in situ* from a comma-shaped mass of undifferentiated tissue by "different degrees of growth in different areas of the mass, and not by elongation of a renal vesicle." The glomerulus is likewise developed *in situ*, completely filling the distal end of the convoluted tubule; "there is no cup formation with subsequent ingrowth of capillaries." The blood system surrounding the metanephric tubules is at first principally sinusoidal, being later almost entirely replaced by a capillary system.

IV. **Ureter.**—The ureteral bud, as is shown in Fig. 491, has its origin from the dorsal surface of the Wolffian duct, a short distance above the point where this

* Development and Growth of the Metanephros or Permanent Kidney in Chick Embryos, Johns Hopkins Hospital Bulletin, xxxiii, 392–406, 1922.

duct enters the cloaca. The "uro-rectal septum," developing at this stage, divides the cloaca into two portions, the rectum behind and the urogenital sinus and the vesico-urethral anlage in front. That portion of the Wolffian duct lying between the ureteral orifice and its distal end gradually becomes shorter and shorter (Figs. 487 and 488). This shortening is due in part to a rolling in and absorption of the Wolffian duct into the wall of the vesico-urethral anlage (Pohlman[35]). As a consequence both the Wolffian duct and the ureter come to acquire separate openings into the vesico-urethral anlage, the orifice of the ureter being lateral to that of the Wolffian duct. With the further growth of the bladder the orifice of the ureter is carried upward, while that of the Wolffian duct remains more caudally situated (Fig. 489). The upper portion of the vesico-urethral anlage containing the ureteral orifice expands to form the bladder, while the lower portion, containing the orifice of the Wolffian duct, remains relatively narrow and forms the urethra.

V. **Change in Position of Kidney.**—The ureteral bud, arising in the caudal portion of the embryo, at first grows dorsally toward the primitive vertebral column. As it increases in length it curves and grows upward for a short distance. It reaches its definitive position early (embryos of 9.5 to 13 mm.) at a time when the ureter is relatively short. With the increase in the length of the body, which takes place mostly in the lumbar region, there is a corresponding growth of the ureter. The great length of the ureter, therefore, is to be accounted for by an increase in the length of the body between the two fixed points of the ureter, namely, the kidney pelvis and the ureteral orifice. The actual upward migration of the kidney is, therefore, relatively slight, and what little there is takes place at a very early stage. The slight migration of the kidney is remarked upon by Bremer,[7] who used the dorsal segmental arteries and the bifurcation of the aorta as fixed points. So far as the blood-supply is concerned, he finds that the upward growth of the kidney is completed in embryos of 15 mm.

In addition to the upward change in the position of the kidney there is also a rotation of the kidney on its vertical axis. When the renal pelvis first develops it faces anteriorly, but it later comes to face medially. This change is brought about by an actual rotation of the kidney through an angle of 90 degrees. It takes place as the first collecting tubules are being formed.

B. Anomalies of the Kidney

In the preceding paragraphs we have attempted to outline briefly the essential points in the normal development of the kidney and ureter. Defects in the developmental processes may occur at any stage, and thus a great variety of anomalies is possible. In the following description these have been grouped under the several headings: anomalies of number, form, position, structure, and vascular supply.

I. **Anomalies of Number.**—1. Bilateral Absence.—Complete absence of both kidneys is sometimes found at birth. The condition is usually associated with other equally serious defects of development, and consequently gives rise to a non-viable monster. Its consideration, therefore, is of importance to the teratologist rather than to the clinician.

2. Unilateral Absence (Single Kidney).—Unilateral absence of a kidney, provided there is a normal healthy kidney on the opposite side, is in every way compatible with normal existence. Since the condition *per se* gives rise to no symptoms, the majority of cases reported have been found at autopsy. In the consid-

eration of the condition we must distinguish between complete absence of the organ, a true agenesis, and a later degeneration of it. Associated with the former there is usually complete absence of the ureter, while in the latter some remnants of the degenerated kidney and ureter can usually be found. A distinction is also to be made between the condition of unilateral absence of a kidney and the apparent absence of a kidney due to the abnormal fusion of the kidneys of the two sides.

Complete absence of the kidney is due to a failure of the ureteral bud to develop. That it may also be due, as stated by Kelly and Burnam,[26] to the early degeneration of the ureteral bud, is possible, but the degenerative forms can only be proved when some remnants of the kidney remain. With complete absence of the kidney there is usually a complete absence of the ureter and ureteral orifice (Fig. 494), but in a number of the cases reported remnants of a ureter have been found; in some, nothing more than a blind ureteral orifice.

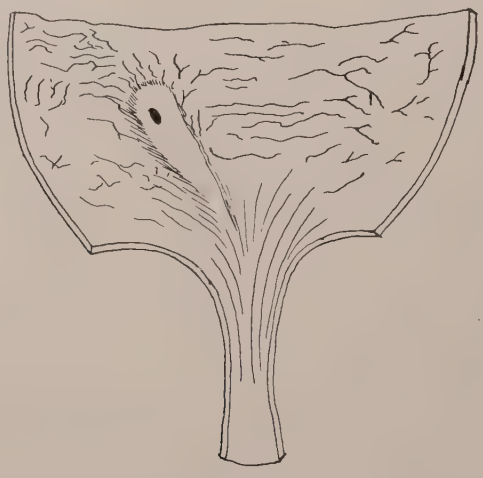

Fig. 494.—Absence of the left half of trigone and ureteral orifice in a case of single kidney. After Ballowitz.

The frequency of single kidney, as determined by Ballowitz[3] from a collected series of autopsies, is given as follows:

TABLE 135

Brown	3	cases in	12,000	autopsies
Morris	2	"	8,068	"
Sangalli	3	"	5,348	"
Menzies	2	"	1,790	"
Rootes	1	"	600	"
Ballowitz	1	"	617	"
Total	12	"	28,423	"
Average	1 case in about 2400 autopsies			

In 1895 Ballowitz collected 213 cases from the literature, and to these Anders[2] in 1910 added 73 cases. Of these 286 cases the sex was mentioned in 248, of which 159 were males and 89 females. This ratio of about 2 to 1 is not significant, as the greater number of autopsies are on males. The single kidney was found 153

times on the left, 120 times on the right. The ureter was reported completely absent in 248 cases; in 24 it was more or less rudimentary.

Complete absence of one kidney always results in a compensatory hypertrophy of the other. There is also an enlargement of the renal pelvis as shown by Braasch,[6] which is not present in those cases of compensatory hypertrophy coming on later in life.

The condition of single kidney does not become of clinical importance until it becomes diseased. The statistics of Anders show, however, that it is especially prone to pathologic change; thus, out of 170 cases, 79 showed changes other than hypertrophy as follows: Chronic interstitial nephritis, 19; chronic parenchymatous nephritis, 2; chronic nephritis, variety not mentioned, 11; pyelonephritis, 10; ureteral calculus, 9; pelvic calculus, 6; hydronephrosis, 4; cystic kidney, 3; tuberculosis, 2; other conditions, 15.

Although the condition is infrequently found, it should be ruled out before contemplated operative procedures on a kidney. Ransohoff[37] has collected 11 cases from the literature in which the single kidney was operated upon, 4 nephrotomies and 7 nephrectomies. The latter succumbed in one to eleven days following the operation. The diagnosis of single kidney can be made with a fair degree of certainty by our present-day methods. Cystoscopic examination, catheterization of the ureter if a ureteral orifice is present, a separate renal function test, and pyelograms will give the required information. Braasch found 6 cases of single kidney out of 38 cases of renal anomalies; 4 of these were diagnosed clinically and demonstrated at operation.

Associated with the anomaly are often found malformations of the genital organs, such as uterus bilocularis unicollis, uterus unicornis, pseudohermaphroditism, etc. Out of 135 cases in which the condition was mentioned, Anders found 94 which showed changes in the genitalia. Guthrie and Wilson[16] reported a case in a female which showed complete absence of the genital and urinary organs of one side; a similar condition found in a cat was reported by Radasch.[36]

3. Supernumerary Kidney.—Two varieties of this condition are found, the free and the fused. Under *free supernumerary kidney* are to be considered only those cases in which there are found two entirely separate kidneys on one side with a normal kidney on the other. The supernumerary kidney always lies at a lower level than the normal one, and is frequently found in the lower iliac region or pelvis. Its form is usually somewhat distorted, its size smaller than the normal.

The usual explanation for this anomaly is that it is the resultant of a supernumerary ureteral bud. That it may also be due to the complete splitting of the renal anlage as in the case of double kidney is obvious, since cases of free supernumerary kidney have been described where the splitting of the ureter was incomplete.

Free supernumerary kidney is one of the rarest of renal anomalies and the reports of cases in the literature are relatively few. As the condition may be entirely symptomless the majority of cases have been found at autopsy. Isaya[21] collected 10 cases found at autopsy and 5 which were diagnosed during operation. To the latter he added 1 case of his own observation. The patient, a woman of twenty-seven years, had, from the age of six, suffered from intermittent attacks of pain in the right lumbar region. The attacks were accompanied by nausea and vomiting. On palpation a hard, elastic tumor was made out to the right of the

umbilicus. Exploratory laparotomy disclosed the presence of a supernumerary kidney on the right side, the ureter of which joined with that of the normal right kidney. In the case reported by Josephson[24] the ureter of the supernumerary kidney terminated in the vulva lateral to the urinary meatus. The case of Depage[13] was characterized by sharp lancinating pain in the epigastrium.

Fused supernumerary kidney is usually found in cases of double ureter and pelvis. The kidney is elongated and oftentimes shows evidence of a transverse sulcus which incompletely divides it into two parts. Sometimes the sulcus is quite shallow or not indicated at all; at other times it is deep, leaving only a small bridge of renal parenchyma or connective tissue binding the two together. An analysis of this condition will show that it is quite similar to that of free supernumerary kidney, the difference being merely one of degree. Embryologically such kidneys are the result of a splitting of a ureteral bud, or the development of two separate ureteral buds, with a single or incompletely divided primitive metanephrogenic cap. Such kidneys are commonly called double kidneys; compared with the free supernumerary kidney their frequency is very much greater.

II. **Anomalies of Form.**—Under this heading are included only two types of cases, simple variations in the form of the kidney and the fusion anomalies. The first group comprises those minor variations in form in which the renal pelvis and ureter are single and essentially normal. Kidneys of unusual length are known as "elongated kidneys" (not to be confused with elongated unilateral kidney), one of diminished length, "short kidney"; a rounded one, an "annular kidney," etc. Such shapes are not uncommon, and although interesting anatomically, have no clinical significance.

The second group comprises those cases in which the form variation is due primarily to the fusion of parts of the two kidneys. In certain instances there is associated with the fusion anomaly a doubling of the kidney of one or both sides, so that some of these anomalies present more than two separate pelves and ureters. The varieties of fusion anomalies which are possible have been discussed and figured by Pohlman.[34]

1. Horseshoe Kidney.—The term "horseshoe kidney" is applied to those anomalies in which there is a fusion of either the lower or upper poles of the two kidneys across the midline of the body. Fusion at the lower poles is the commoner type. The degree of fusion varies greatly, it may be composed of connective tissue alone, or it may involve varying proportions of the renal parenchyma. In some cases the "isthmus" is as large as the body of either kidney, so that the anomaly takes the form of an almost uniform semicircular mass of renal substance; in others it may be made up of irregular segments. The isthmus usually lies anterior to the aorta and vena cava, but cases have been reported where it was placed behind them or even between the two. The position of the horseshoe kidney may vary from the normal kidney level to the pelvis. The ureters, usually two in number, arise from separate pelves, which may be situated on either the medial or anterior surfaces. Variations in the number and position of the ureters, however, have been described.

The time at which the union of the two kidneys take place to form this as well as other fusion forms has not been definitely determined. It must, however, take place at an early stage, judging from its position and its relations to the larger vessels. At the time when the renal anlagen appear they are both directed pos-

teriorly and are relatively close together. With the formation of the metanephrogenic caps the parenchymatous portions of the kidneys are brought into even closer relationship. It is presumed, therefore, that in certain cases the poles of the renal anlagen meet in the midline and that a definite fusion takes place. From a study of the position of the renal pelves it is evident that the time of fusion varies. In those cases where the pelves face medially the fusion undoubtedly takes place after the rotation of the kidney has been completed, that is, after the first of the collecting tubules have formed. In cases where the pelves are directed anteriorly it is evident that fusion takes place earlier, and thus prevents the normal rotation

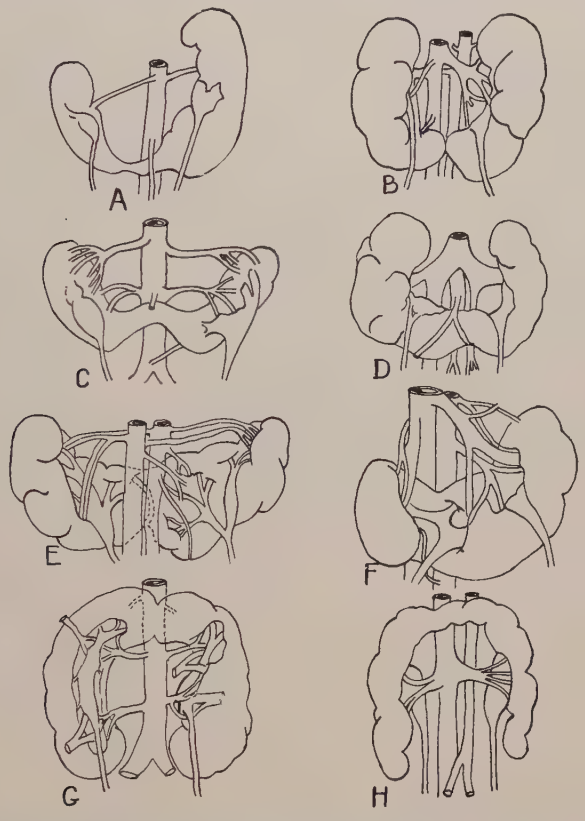

Fig. 495.—Cases of horseshoe kidney collected from the literature by Judd, Braasch, and Scholl. Various types of isthmuses are shown. Fusion of the lower poles in A to F; of the upper poles in G and H. In E the isthmus lies behind the great vessels.

of the kidney. Once fusion has been affected, it is accountable for certain other and greatly varying irregularities, such as malposition, abnormal pelves and ureters, abnormalities in the blood-supply, etc.

Horseshoe kidney is one of the most frequent of renal anomalies. Naumann,[30] in a series of 10,177 autopsies, found 100 malformations of the kidneys, of which 17 were horseshoe kidneys, or 1 in about every 600 cases. This is somewhat higher than the ratio obtained by Davidsohn,[12] 6 cases in 6200 autopsies, or 1 to 1000. The ratio is placed at 1 to 850 by Carlier and Gerard[11] from a collected series of 68,000 autopsies.

Horseshoe kidney may or may not give rise to symptoms, depending upon its

position and whether or not the renal substance undergoes pathologic change. That it frequently does produce symptoms is shown by the figures of Botez,[5] who found that in 320 cases of horseshoe kidney, 52, or about 16 per cent., were incapacitated by the condition. Judd, Braasch, and Scholl[25] state that of 2424 operations performed on the kidney at the Mayo Clinic, 17 were on horseshoe kidney. Horseshoe kidneys are especially predisposed to hydronephrosis owing to the unusual position and curvatures of the ureter, to renal calculi, renal tuberculosis, pyonephrosis, and infections of the pelvis.

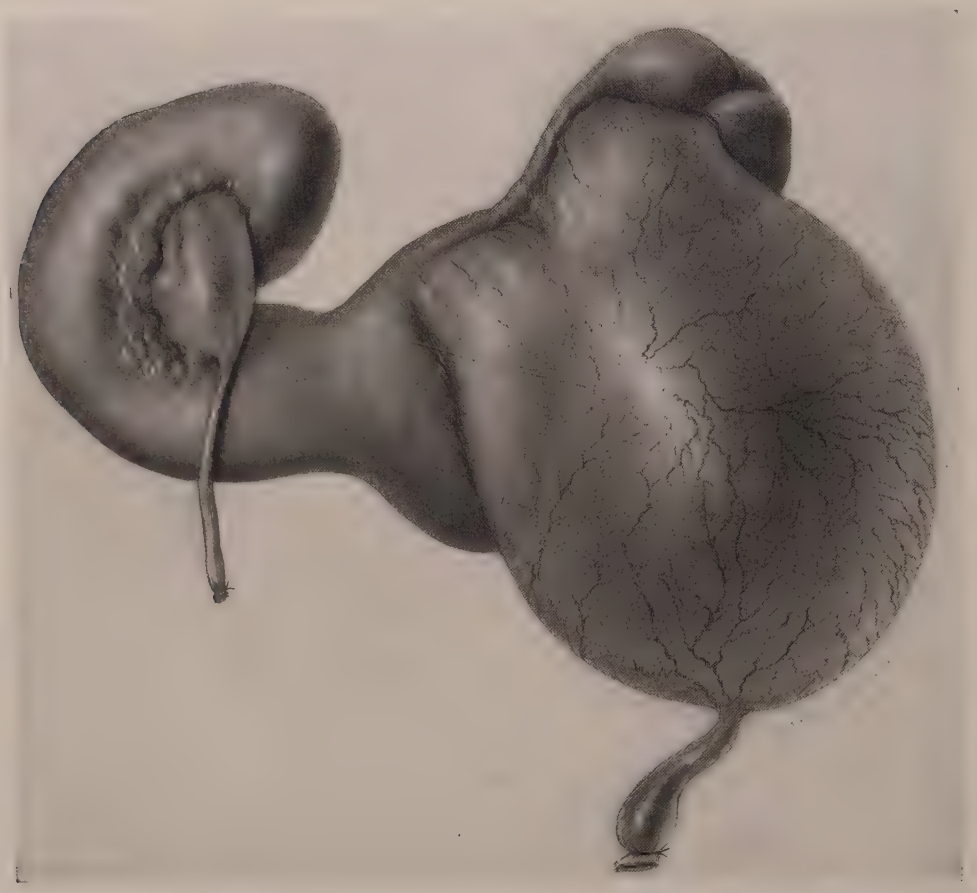

Fig. 496.—Autopsy specimen from J. H. H. Path. Dept. Horseshoe kidney showing extrarenal hydronephrosis of both pelves, more marked on the left. Cause of obstruction undetermined. The outline of the left half of the kidney can be made out through the semitransparent hydronephrotic sac.

There are no symptoms characteristic of horseshoe kidney. The presence of the usual symptoms of surgical kidney with a palpable tumor is suggestive. The so-called "Rovsing" sign, the causation of a characteristic pain by increasing the curvature of the lumbar spine or making the muscles of the back tense, which is relieved when the patient lies down, is, according to Judd, Braasch, and Scholl,[25] of little diagnostic value. In 16 cases reported by these authors a diagnosis of horseshoe kidney was made in 2, and of congenital anomaly of the kidney in 2 others. The criteria for the diagnosis were based upon the appearance of the

double pyelogram; the renal pelves were lower and closer together than normal and faced anteriorly. The outline may show in a plain *x*-ray.

2. Disk Kidney.—This condition, also called scutiform or shield-shaped kidney (*rein en gateau*), has a rounded, flattened shape. As a rule, it is situated lower than horseshoe kidney, at the pelvic brim or in the concavity of the sacrum, and may lie more to one side than the other. It lies close to the posterior body wall and its posterior surface conforms to the structures with which it comes in contact. The anterior surface is usually lobulated and from it arise the renal pelves and ureters. Its blood-vessels pierce the posterior surface and are variable. From the embryologic standpoint this type of anomaly bears a close relationship to horseshoe kidney, the fusion taking place along the whole of the medial border before rotation has been effected.

3. Sigmoid Kidney.—This term, first used by Broesike,[9] has been given to that type of anomaly which results from an end-to-end anastomosis of the two kidneys (lower pole to upper pole), and which presents a double curvature of

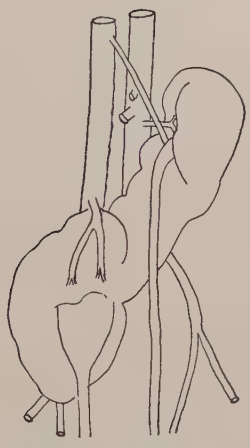

Fig. 497.—Sigmoid kidney; fusion of the upper pole of the right kidney with the lower pole of the left kidney. The pelvis of the right kidney faces anteriorly, indicating failure of rotation. The ureters end normally in the bladder. After Winternitz.

the sigmoid type. In the case reported by Broesike the sigmoid kidney was found entirely to the left of the midline; in the one reported by Winternitz[46] the main masses of the two kidneys were found on either side of the midline, but the lower pole of the left kidney was connected with the upper pole of the right by means of a connecting link of renal parenchyma (Fig. 497). In the former the right ureter crossed the midline to reach the right side of the bladder; in the latter the ureters were normal. The 2 cases, therefore, are not altogether similar, one combines a fusion anomaly with crossed dystopia, the other fusion with simple dystopia. In order to avoid confusion it would seem preferable to restrict the term "sigmoid" to that type of kidney described by Winternitz, and "unilateral elongated" kidney to that where the fused kidney lies entirely on one side of the midline.

4. Other Fusion Forms.—Fusion may take place between two kidneys lying at approximately the same level, but one placed anterior to the other. Such a case has been described by Morris.[29] The kidney formed an irregular mass lying on the sacral promontory. The left ureter entered the central mass, the right

on the right lateral surface. A somewhat similar case is figured by Kelly and Burnam,[26] but in this case both ureters entered on the anterior surface. Cases of this type, without regular form, are known as "lump kidney." The case described by McMurrich[27] presented a still different form. In this there was crossed dystopia with anteroposterior fusion of the two kidneys. Under the term "four kidneys in a human being" Oleson[31] has described a horseshoe kidney with fusion at the lower poles, with free supernumerary kidneys above. The ureters on each side were completely doubled.

III. **Anomalies of Position.**—In addition to the minor variations in the position of the kidneys which are frequently observed, cases are occasionally found where the kidneys show marked change from the normal. Such ectopic kidneys may be either acquired or congenital. The former constitute those cases of nephroptosis in which the descensus is due to the increased weight of the organ through hydronephrosis or tumor, to faulty attachments, to pressure, etc. They are characterized by elongated ureters which by their bends or loops show evidence

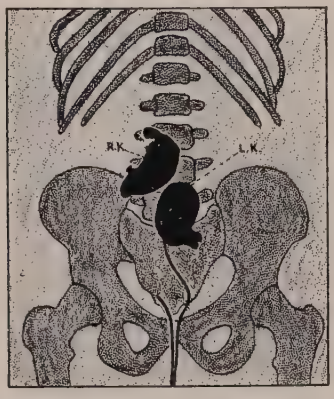

Fig. 498.—A case of hydronephrosis in bilateral ectopic kindey. Composite drawing from two pyelograms. From the Gynecological Service, Johns Hopkins Hospital.

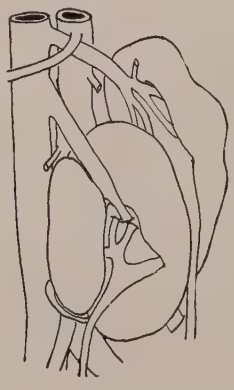

Fig. 499.—Case of crossed dystopia with anteroposterior fusion of the kidneys. The ureters end normally in the bladder. After McMurrich.

of descent. The congenital ectopic kidney, on the other hand, is one which has never reached the normal level and is characterized by a ureter which is usually shorter than normal. The condition is usually unilateral, but may be bilateral. When the ectopic kidney lies on its proper side of the body but at a lower level, the case is one of "simple dystopia"; when it lies on the opposite side of the body, it is one of "crossed dystopia." Anomalies of the kidneys may occur alone, but are more often found in connection with other anomalies. A large percentage of horseshoe kidneys are characterized by abnormal position; cases of sigmoid, disc, and lump kidney are invariably lower in position than normal.

The frequency of ectopic kidney is shown by Naumann,[30] who, in a collected series of 10,177 autopsies, found 20 cases of this condition. Of these, 12 were on the left side, 5 on the right, and 3 bilateral. Of the 38 anomalies of the kidneys studied by Braasch,[6] 3 were ectopic kidneys. The condition is more common in women than in men, for in the 66 cases collected by Sträter[42] 53 were in women and 13 in men.

1. Simple Dystopia.—In cases of simple or uncrossed dystopia *without fusion*

the kidneys are commonly found in the true pelvis. Of the 9 cases described by Joseph,[23] the ectopic kidney was found in the pelvis in 6, at the pelvic brim in 3. The size of the kidney is usually small and its form abnormal. The ureters are short, but enter the bladder normally. The blood-vessels show marked variation from normal, being multiple and arising from the nearest portion of the aorta, or from the common or internal iliac arteries.

Cases of uncrossed dystopia *with fusion* comprise those fusion forms, such as horseshoe kidney, sigmoid kidney, etc., which have been discussed above.

2. Crossed Dystopia.—In crossed dystopia both kidneys lie on the same side of the body, the ureter of the ectopic kidney crossing the midline and terminating normally in the opposite side of the bladder. The latter condition is emphasized by McMurrich[27] in order to distinguish it from a double kidney with double ureter. In 80 cases of crossed dystopia collected by Papin and Palazzoli,[32] 70 showed fusion, while in only 10 were the two kidneys separate. The fusion may be side to side (lateral fusion), as in the case of McMurrich (Fig. 499), or it may be end to end. Cases of the latter type give rise to "elongated unilateral kidney" or the

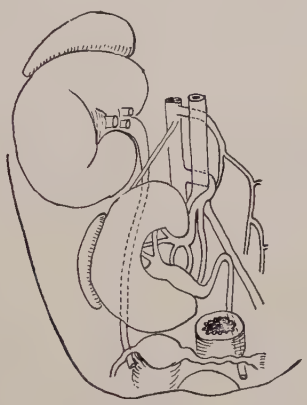

Fig. 500.—Case of crossed dystopia without fusion. The ureters end normally in the bladder. The relationship of the blood-vessels of the dystopic kidney indicate a late displacement. After Papin and Palazolli.

"symphysis renale unilaterale" of the French writers. In the latter condition the normal kidney occupies its normal position, while the ectopic one lies below it. The form of the uncrossed kidney is usually normal; that of the crossed, modified; the hilus of the normal usually faces medially, that of the crossed kidney faces anteriorly, thus giving evidence of a failure of rotation. In 66 cases in which the side was mentioned, Papin and Palazzoli found both kidneys on the left in 31, on the right in 35. Of the 10 cases of crossed dystopia without fusion the same authors found both kidneys on the left in 2, on the right in 8. Here again the normal kidney occupies its normal position, while the ectopic one lies at the pelvic brim or wholly within the pelvis.

Embryologically, cases of simple ectopic kidney are to be accounted for by a failure of the kidney to reach its definitive position. It has been shown above that the actual migration of the kidney is relatively slight and that it is completed at an early stage. The kidney becomes fixed while the ureter is still quite short. The further apparent migration of the kidney is caused by the rapid growth of the body between the kidney and the vesical end of the ureter. Yet

slight though the migration of the kidney really is, complete or partial failure of it will give rise to correspondingly marked abnormality in position.

Cases of crossed dystopia are more difficult to comprehend. The crossed kidney develops on its own side of the body as is made evident by the position of the ureteric orifice. Whatever the force may be which attracts the kidney to the opposite side of the body, we know that it does not always act at the same time. This is made evident by a study of the blood-vessels. These usually spring from the same side of the body on which the kidney is found; in the case shown in Fig. 500, however, the reverse condition exists, indicating a later displacement.

Fig. 501.—Case of nephroptosis. Pyelogram of left kidney taken with patient lying on his back. (During reproduction this picture has been reversed so that the left kidney is shown on the right side.) B. U. I. *x*-Ray 70.

Ectopic kidney only infrequently gives rise to symptoms unless associated with other disease. The diagnosis is easily made by means of pyelography.

Movable kidney must be sharply distinguished from ectopic kidney. Ectopic kidney has abnormal vascular and fascial attachments and is fixed in an abnormal location. Movable kidney, however, is usually attached in a normal way, but owing to unusual length and looseness of those attachments, drops far below the normal limits. The kidney may even, in extreme cases, be almost completely covered by peritoneum, becoming a pedunculated organ. Such cases seem to belong justly in the classification of anomalies, and while there are all stages of severity, the milder of which scarcely depart from normal, it is convenient to consider the entire subject at this point.

The normal mobility of the kidney in women is given by Kelly,* who has made a thorough study of this condition, as 1.5 to 5 cm., and about half this in men. When these limits are exceeded there is an accompanying laxity of the perirenal fascia (capsule of Gerota, Küstner, or Zuckerkandl). The perirenal fat, therefore, accompanies, at least partially, the kidney in its descent, but the upper part of the fascia, with the fat and the adrenal gland contained in it, is more firmly fixed, and never descends with the kidney. The vessels become elongated in long-standing cases, while the ureter has to adapt itself to the movements of the kidney. While it usually retains its permeability, it may, if it is pulled over a band of adhesions or around an aberrant artery, become partially or completely occluded, producing hydronephrosis.

Fig. 502.—Case of nephroptosis. Pyelogram of left kidney taken in the standing position. (During reproduction this picture has been reversed so that the left kidney is shown on the right side.) B. U. I. x-Ray 70.

Nephroptosis is often associated with descent of other abdominal organs or with a general visceroptosis. Some authorities, such as Glénard, Tuffier, and Israel, believe that this association is always present, while others, as Kelly and Albarran, feel that in the majority of cases of nephroptosis there is no displacement of any other organ. In 237 of Kelly's cases 149 were uncomplicated, while in 65 there was also retroflexion of the uterus and in 23 gastroptosis. In the same way Kelly believes that there is little relationship with poor nutrition, since of his cases only 78 were very thin, while 104 were of average weight and 63 well nourished. On the other hand, the addition of 10 or 15 pounds of weight not in-

* Diseases of the Kidneys, Ureters, and Bladder, 1914, i, 459–519.

frequently relieves the symptoms of nephroptosis. A history of injury is seldom elicited—13 of Kelly's 242 cases.

Abnormal mobility of the kidney is more frequent in women than it is in men. Of 4576 women in the collected statistics of Kelly, 1049 had movable kidney (22.8 per cent.); 3277 men yielded only 71 cases of movable kidney (2.1 per cent.). The right kidney is affected more often than the left, and both kidneys more often than the left kidney alone. (Of 542 collected cases, the right kidney was movable in 434, the left in 40, and both in 68.)

In Kelly's series the ages were as follows: fifteen to twenty, 5 cases; twenty to thirty, 94 cases; thirty to forty, 95 cases; forty to fifty, 40 cases, fifty to sixty, 7 cases; over sixty, 1 case. The average duration of symptoms was five years.

Fig. 503.—Case of nephroptosis. Pyelogram of right kidney taken with patient lying on his back. (During reproduction this picture has been reversed so that the kidney appears to be on the left side.) B. U. I. *x*-Ray 70.

Symptoms.—Abnormal mobility of the kidney often gives no symptoms; according to Kelly in only 1 case in 10 are serious symptoms present. The most constant is pain, either a constant aching pain or colicky spasms. The latter resemble true renal colic closely, and are often known as "Dietl's crises." They are undoubtedly due to traction upon or kinking of the ureter. Other symptoms are largely gastro-intestinal, and often described as "indigestion": anorexia, belching, distention, constipation, etc. Nephroptosis is often present in neurotic individuals, with a multiplicity of symptoms due to the neurosis. Nephropexy fails to relieve these patients unless by its psychic effect, which is about as apt to be bad as good.

Diagnosis depends on palpation and on the *x*-ray. In thin individuals the

lower pole of the kidney may be palpated and its excursions determined in various positions of the patient. In extreme cases the hand may be pressed in above the upper pole, entrapping the kidney in its descended position. The *x*-ray is more accurate. Unless the kidney outlines can be seen in the plain plate the pelvis must be injected with a pyelographic medium. The catheter is withdrawn into the pelvic ureter to avoid any interference with the movements of the kidney. A picture is then made with the patient's head slightly depressed—showing the kidney in its uppermost position—and then a second, with the patient's body nearly or quite vertical, allowing the kidney to descend as far as possible. Comparison of the two pictures gives exactly the excursion of the kidney (Figs. 501–504).

FIG. 504.—Case of nephroptosis. Pyelogram of right kidney taken in the standing position. B. U. I. *x*-Ray 70.

Much has been written on the influence of body form on the mobility of the kidneys. Individuals with long, narrow chest and acute costal angle are supposed to be more subject to nephroptosis. Bechu and Lendorff and Harris have attempted to express this relationship in figures.

The formula of the first is: $\frac{\text{distance from sternal notch to symphysis}}{\text{shortest circumference of abdomen}} \times 100 = \text{F},$

and of the second: $\frac{\text{distance from sternal notch to symphysis}}{\text{circumference of body at tenth rib} + \text{circumference of body at lower end of sternum}} = \text{F}'.$

If F is above 75, or F′ above 77, there is likely to be nephroptosis. Thirty-one women with movable kidney showed an average F′ of 76.5, 51 women without movable kidney, an average F′ of 71.1, and 24 men an average F′ of 67. On the other hand, Kelly has found so many exceptions to the rule that he thinks little weight can be given to these indices.

Extremely movable kidneys are somewhat less apt to give symptoms than those having excursions of from 8 to 10 cm.

In general, however, great conservatism is necessary for the diagnostician in ascribing symptoms to movable kidney. Since in 9 cases of every 10 no symptoms are caused, all other conditions must be carefully ruled out. It has been found in many cases that nephropexy failed to relieve the patient. If, however, the examination is thorough and painstaking a certain number of cases will be found in which nephroptosis is really responsible for the trouble, and these cases will be cured by successful nephropexy. In over 12,000 cases at the Brady Institute (mostly men, of course) we have had occasion to perform nephropexy only 10 times, yet in these patients relief was complete.

Treatment.—If the patient is not well nourished, a supporting bandage may be tried, and the patient put on a regimen calculated to increase his weight. This will sometimes give complete relief. If unsuccessful, nephropexy must be done. The method to be chosen is one which does not mutilate the kidney. We have usually employed the triangular stitch of Kelly, fastening the kidney to the twelfth rib without decapsulation.

Kelly's results are indicated in the following table:

TABLE 136

Kidney involved:	Right.	Left.	Both.	Both.	Both.
Kidney suspended:	Right.	Left.	Both.	Right.	Left.
Cured	85	7	12	5	4
Failed	7	2	6	5	2
Lost to view	23	6	3	3	2
Total	115	15	21	13	8

A recent summary by Hunner* shows that many fewer operations are now performed in the Gynecologic Department of the Johns Hopkins Hospital than formerly for movable kidney. The ultimate results of nephropexy have proved less favorable in cases followed for a long time, and the other forms of treatment have shown better results when faithfully carried out.

IV. **Anomalies of Structure.**—1. CONGENITAL HYPERTROPHY of a kidney has been noted in those cases of congenital absence, or marked atrophy, of the opposite kidney. The kidney is characterized by its increased size and functional capacity. Unlike the kidney of acquired compensatory hypertrophy, there is an enlargement of the renal pelvis as well as an increase of the number of the glomeruli and collecting tubules. Such an increase may be accounted for by a failure in the normal reduction of the collecting tubules, for, as Felix[14] has shown, the number of collecting tubules formed in the early stages is in excess of the number present in the adult.

* Personal communication.

With the failure of the development of one kidney, and consequent enlargement of the other, these extra collecting tubules are probably retained, and give rise to an increased number of uriniferous tubules and glomeruli.

2. Congenital hypoplasia of a kidney is not infrequently seen. The kidney is usually smaller than normal, may show evidence of fetal lobulation, and quite often shows solitary or multiple cysts. All grades are found between the normal kidney and the complete absence of the organ. *Fetal lobulation* is a form of hypoplasia in which the surface of the kidney is traversed by sulci which divide the renal

Fig. 505.—Autopsy specimen of polycystic kidney. Note the great variation in the size of the cysts. Courtesy of Dr. M. C. Winternitz.

parenchyma into rounded or irregular lobes corresponding to the Malpighian pyramids. The condition is normal for the fetus and infant, but normally disappears at the age of four years. It is due to a failure of the renal parenchyma of the columns of Bertini to develop to its full extent. Among 100 renal malformations Naumann[30] found 5 cases of high-grade fetal lobulation. Hypoplastic kidneys are predisposed to disease, such as tuberculosis, calculi, etc. Symptoms from the condition *per se* are not present unless it is bilateral and the total renal function is low.

3. Atrophic Kidney.—Unfortunately no clear distinction has been made between this condition and that of hypoplasia. Kidneys which are undersized are usually spoken of as atrophic, without regard to whether the smaller size is due to a lack of development or to degenerative changes. That congenital atrophy does occur is made certain by the findings in certain cases of single kidney which have been described, in which the ureter and remnants of a degenerated kidney are found on the opposite side. Seven cases of atrophic kidney, of which 1 was bilateral, were found by Naumann[30] in 100 renal anomalies; Braasch[6] found 5 cases in 38 renal anomalies.

Fig. 506.—Autopsy specimen of polycystic kidney. Median section showing how deeply many cysts are situated. Courtesy of Dr. M. C. Winternitz.

Atrophic kidneys, whether congenital or acquired, are of the greatest clinical importance, since they are usually unable to sustain life if the other kidney is destroyed or removed. Since the ureteral orifice may be normal, and the urine secreted of normal composition, the diagnosis may be missed. A pyelogram usually reveals the condition, and a divided phthalein test is also of great value. Since the parenchyma of the undersized organ may be normal, the appearance time of the phthalein is often unchanged, but the total excretion for a given time is much re-

duced. This finding is almost pathognomonic, since a quantity reduction due to disease is practically always accompanied by a delayed appearance time.[47, b.] The anomaly is of sufficiently frequent occurrence that it must be considered and ruled out in every case where nephrectomy is contemplated.

4. Congenital Cystic Kidney.—The condition of polycystic kidney is one which has always created great interest among pathologists and clinicians, and a very large literature on the subject has grown up. The kidneys are usually larger than normal and are sometimes enormous. They may extend across the midline and into the pelvis, so that it is possible to palpate them through the vagina. The surfaces are irregular owing to the underlying cysts. Some of the cysts are very thin walled and semitransparent. The kidneys are characterized by a variety of colors—grays, various shades of yellow, red, and blue. When sec-

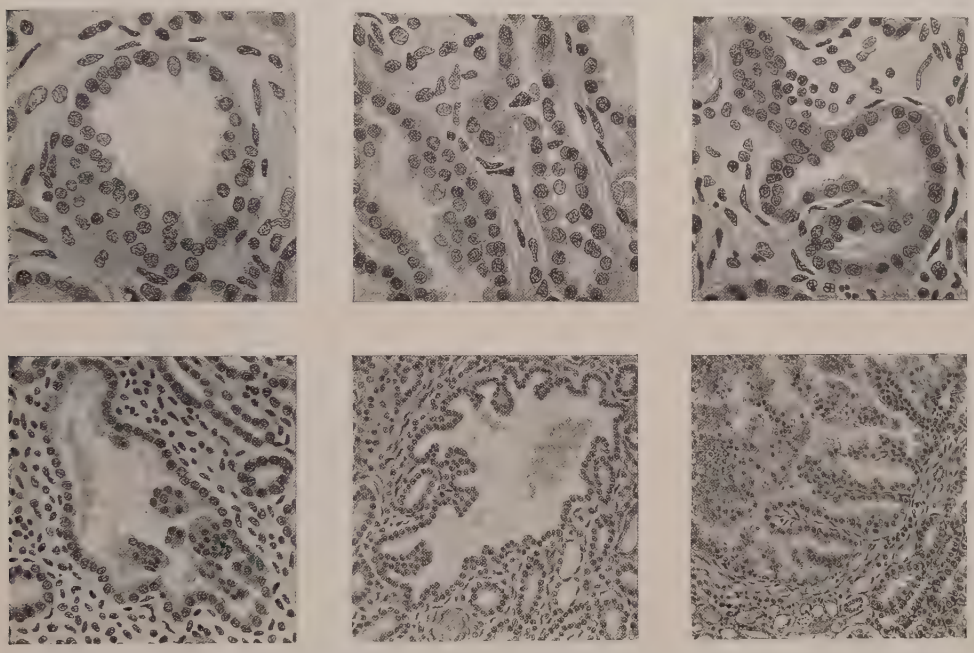

Fig. 507.—Drawings of microscopic sections showing beautifully the intracystic epithelial proliferation, both in the form of thickened masses and papillary projections, from a case of polycystic kidney. From McKinlay, Journal of Urology, 1920, iv, 195–207.

tioned the whole kidney seems to be made up of nothing but cysts of various sizes, but on closer examination small areas of normal appearing kidney parenchyma are found between the cysts (Figs. 505, 506).

Several theories have been advanced regarding the formation of polycystic kidneys, and of these, three deserve mention. According to Virchow,[44] the cysts are due to retention resulting from a closure of the papillary ducts by deposits of uric acid and calcium salts. Virchow later modified this view, believing that the closure was due to an inflammation of the papillæ, hence the term "nephropapillitis." This view has now been completely abandoned, owing largely to the experimental studies of Petterson[33] and Tollens,[43] who have shown that obstruction of the papillary ducts is followed not by cyst formation, but by an atrophy of the tubules.

The neoplastic theory of Bridigi and Severi[8] received considerable support and has not yet been completely given up. These investigators noted epithelial proliferation or sprouts from the tubules of the kidney into the connective tissue surrounding them, *epithelial nests*, which they thought became converted into cysts through degenerative changes, and pseudopapillary formations on the inner walls of many of the cysts (Fig. 507). The condition showed marked similarity

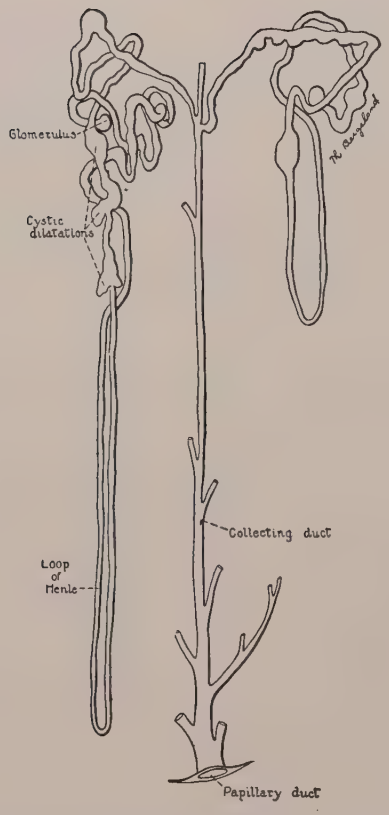

FIG. 508.—From a case of early polycystic kidney. Semidiagrammatic sketch to show the general relationship of the renal tubules and cystic dilatations. After Greene.

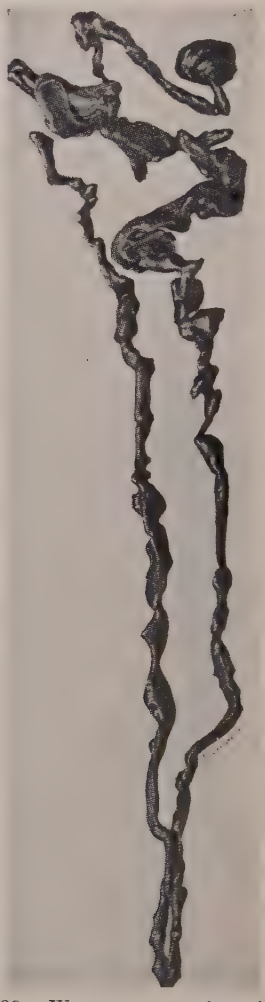

FIG. 509.—Wax reconstruction of a uriniferous tubule from an early case of polycystic kidney. The glomerulus, proximal convoluted tubule, loop of Henle, and beginning of distal convoluted tubule are shown. After Greene.

to that found in cystadenomas of the ovary, and they advanced the idea that it was a true neoplasm.

The third view is that of Hildebrandt,[18] who based his conclusions upon our present-day conception of the dualistic formation of the uriniferous tubules. He believed that the cyst formation is due to a failure of the union between the collecting tubule and the metanephrogenic anlage; with the beginning of secretory activity

of the glomerulus and kidney tubule a cyst is formed. This view was confirmed by Ribbert,[38] Meyer,[28] and many others, and is today the most generally accepted theory of the formation of polycystic kidney.

However, the question is not entirely settled as yet. The studies of von Mutach,[45] confirmed by Bunting,[10] have shown that a direct continuity could be traced between the cysts and the kidney tubules. Berner[4] found carmine within the cysts after its injection into the ureter. Greene[15] has made wax models of the uriniferous tubules in this condition, as well as isolating them by the hydrochloric acid maceration method, and finds direct continuity between the cysts and the collecting tubules. He concludes that retention alone is insufficient to explain the mode of formation of the cysts (Figs. 508, 509).

The frequency of polycystic kidney is given by Naumann,[30] who found 16 cases in 10,177 autopsies; of these 14 were bilateral. Sieber[40] has collected 244 cases from the literature, of which the age incidence is given as follows:

TABLE 137

8 weeks	to	19 years		32	cases
20 years	to	29 years		26	"
30 "	to	39 "		22	"
40 "	to	49 "		67	"
50 "	to	59 "		40	"
60 "	to	69 "		10	"
70 "	to	79 "		6	"
80 "	to	89 "		2	"

He finds that the condition occurs bilaterally about ten times more frequently than unilaterally.

A marked hereditary tendency has always been noted. This is strikingly shown in two families described by Steiner (cited from Sieber). In one family the father, ten-year-old son, and sister of the father had polycystic kidneys; in the second family the father, son, and three sisters of the father were so afflicted, while, in addition, several of the children showed albuminuria.

One of the most common symptoms of the disease is pain. This may occur over a period of years, may come on as a late symptom, or may be entirely lacking. It is usually of a dull aching character and is probably due to the increased size and weight of the kidneys. Hematuria, of an intermittent character associated with pain, lasting for several days or weeks and followed by a complete remission, occurred in about one-half of the cases collected by Sieber. The urine may or may not be normal, depending upon the amount of normal renal tissue left between the cysts. Albuminuria may occur, but is inconstant; casts are seldom seen, red and white blood-corpuscles are found in small numbers.

Of the physical signs, a palpable tumor is the most important. The kidney is felt as an irregular, hard, compact, elongated mass, having an irregular surface. Fluctuation is absent and this sign has been used to distinguish the condition from hydro- and pyonephrosis (Stiller[41]). The finding of bilateral palpable kidney tumors is of great importance, but is not pathognomonic, as Rohrer (cited by Sieber), in a series of 37 kidney neoplasms, found this condition to be bilateral in 5.

The pyelogram is a most important aid in the *diagnosis* of polycystic kidney. In the usual form, where the cysts are mostly in the parenchyma, the kidney is

enlarged in all directions; the effect on the pelvis is most marked in the longitudinal direction, while the calices at either pole may be spread apart. The characteristic

FIG. 510.—Autopsy specimen showing marked cyst formation in chronic pyelonephritis. Note that in this specimen all the cysts are peripheral. Cysts more numerous than usually seen. Courtesy of Dr. M. C. Winternitz.

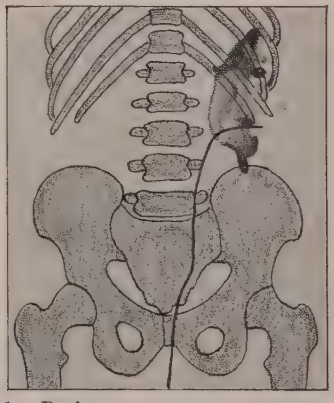

FIG. 511.—Pyelogram of polycystic kidney. From the Brady Urological Institute, *x*-Ray 4820.

FIG. 512.—Pyelogram showing a typical pelvic outline in polycystic kidney. Note the great elongation especially in an up-and-down direction of the major calyces and the distortion of the minor calyces. B. U. I. *x*-Ray 5223.

lengthening of the pelvis, without any dilatation, is pathognomonic, and is well shown in Figs. 511–513. More rarely, if large cysts develop in the lowest portions

of the columns of Bertini, the calyces may be stretched out over their surfaces, elongated, and converted into thin convex slits. This may cause in the pyelogram the appearance of thin lappets like those produced by the invasion of the pelvis by a tumor mass. The remainder of the pyelogram will usually give the diagnosis of polycystic kidney, however.

The urine is usually abundant and of low specific gravity. Hematuria, albuminuria, and cylindruria may occur. When renal insufficiency becomes marked any of the symptoms of uremia may be present, and retention of the urinary constituents in the blood will occur.

The distinction which was formerly made between polycystic kidneys of the adult and those of infancy and early years is no longer held. The tumors are believed to be present at birth, but may not begin to grow until after middle age.

Three types of clinical course of the disease are distinguished by Sieber,[40] although various combinations of these are found. The first is the uremic form with an insidious onset, systemic symptoms of uremia, with death after eight to twenty days. The second is the Bright's form, which is characterized by symptoms of chronic nephritis: cardiovascular changes, edema, albuminuria, etc. This form runs a much longer course, as high as twenty years. In the third type, the renal or surgical form, the symptoms are referable directly to the kidneys: hematuria, lumbar pain, etc. The course is variable, there are attacks and remissions, and it averages about three years in length. Death is due to uremia.

The cause of death in 98 cases as reported by Sieber is as follows:

TABLE 138

Uremia	50
Pneumonia	8
Apoplexy	7
Pulmonary tuberculosis	7
Postoperative	7
General cachexia	6
Pulmonary edema	3
Cardiac insufficiency	2
Chloroform death	2
Sepsis	2
Other conditions	4

A polycystic kidney may be the site of practically any other renal disease, as calculus, hydronephrosis, pyelonephritis, tuberculosis, etc. When this occurs the problem is much complicated.

The *treatment* of polycystic kidney is generally a medical problem, the guiding principles of which are the same as for chronic nephritis. The patient should lead a very careful life as regards exercise, food, drink, and exposure to cold. He should be seen occasionally by his physician and a careful urinary examination and functional tests made to determine the progress of the disease.

When it is definitely determined that the condition is gradually becoming worse, the question of operative intervention must be considered. Much has been written upon the subject and there is still much doubt as to what is the best method to pursue.

In an excellent study of the subject, Brin* has found that nephrectomy has

* Encyclopædie Française d'Urologie, 1914, II.

been carried out in 17 cases. The mortality has been so high that this procedure stands condemned. In 22 cases of nephrotomy or nephrostomy the mortality has been 31.8 per cent. Only 2 patients are reported still alive after two years. Nephropexy and decapsulation have been done a few times. The most efficient procedure has been puncture or incision of the cysts. The method of puncture has been championed by Rovsing, who advises that the kidney be exposed and multiple punctures of the superficial and deep cysts carried out. In 2 cases Rovsing reported that remarkable amelioration had occurred, that the renal function was considerably improved, and that pain, which had been present, had disappeared. Other surgeons have confirmed these results, while some have reported failures. Küster recommends that the superficial cysts be excised as completely as possible. The incision may be done with or without cauterization. Brin collected 16 cases, treated thus, with 4 deaths (25 per cent. mortality). The duration of the results in those who lived cannot be given. When the case is complicated with unilateral infection

Fig. 513.—Pyelogram showing typical pelvic outline in a case of polycystic kidney. Note the flattening of the minor calyces and the great elongation of both major and minor calyces. B. U. I. *x*-Ray 5227.

and suppuration, a calculus with hydronephrosis, or tuberculosis, operation may be indicated and perhaps safely carried out on the affected side, but the fact that the other kidney is practically always polycystic makes any extensive operation hazardous. When fever, associated with anuria or uremia, occurs, one may consider operating upon a badly infected side, but, as a rule, such operations are dangerous.

One may, therefore, sum up the situation in advising that medical treatment as a rule is the method of choice. In some instances surgical evacuation of the cysts may be justifiable. One cannot as yet state what methods are best to employ or what results may be expected.

V. **Anomalies of the Renal Vessels.**—Anomalies of the renal arteries and veins are not uncommon and a great number of variations have been recorded. Because of the general inconstancy of veins interest has centered chiefly in the variations of the renal arteries. The renal artery may divide into its terminal branches immediately upon leaving the aorta, or it may be represented by several arteries arising separately from the aorta. The main trunk or an accessory branch

may arise from the abdominal aorta, common iliac, internal iliac, middle sacral, or inferior mesenteric arteries. Occasionally there is a common stem for both renal arteries arising from the ventral surface of the aorta. The renal artery or an accessory branch may either enter the hilus of the kidney or it may pierce it at any point on its outer surface. Anomalous renal arteries are the rule in anomalous kidneys (fusion forms, ectopic kidneys, etc.); the more marked the anomaly, the greater the variation in the renal vessels.

FIG. 514.—Diagram to show the origin of the renal arteries; the small branches of the aorta situated between the dorsal segmental, mesonephric, and mesenteric arteries, as well as the peri-aortic plexus, are shown. After Bremer.

The frequency of multiple renal arteries is shown by Brewer (cited from Seldowitsch), who, in a study of 151 cadavers, found more than one renal artery on one side in 85 (56 per cent.). Of these there were 70 which showed 2 renal arteries, 12 showed 3, 2 showed 4, and 1 showed 5. Seldowitsch[39] found 43 cases of supernumerary renal arteries in 150 cadavers, or 30 per cent. In 33 cases the supernumerary arteries were unilateral, in 10 bilateral.

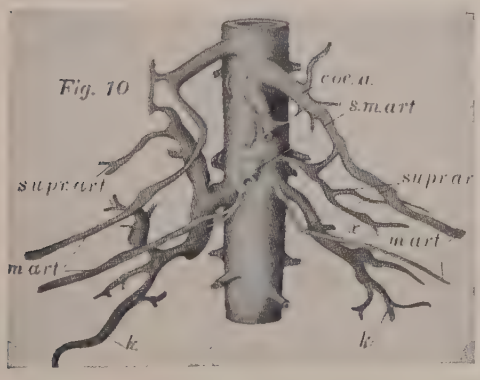

FIG. 515.—Reconstruction showing the development of the renal arteries from the pre-existing peri-aortic net. After Bremer.

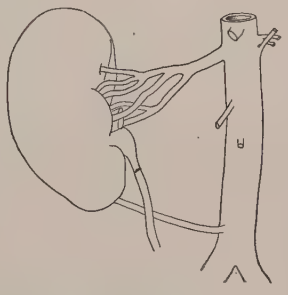

FIG. 516.—Case of multiple renal arteries. After Seldowitsch.

The explanation of anomalous renal arteries arising from the iliacs, middle sacral, inferior mesenteric arteries, etc., is found in the fact that vascularization begins before the upward migration of the kidney, and that these vessels, normally lost, are retained. The view of Hill[19] and others, that the renal arteries grow out from the aorta after the kidney has reached its definitive position, is not confirmed by the observations of Bremer[7] on early human embryos. This author states that at the time of the kidney migration the abdominal aorta is a well-formed vessel with thick mesenchymal walls and that this vessel is beyond the stage where it can

give rise to new vessels. The anlagen of the renal vessels must, therefore, be sought for in some pre-existing vessels. These he has found in the "peri-aortic plexus"

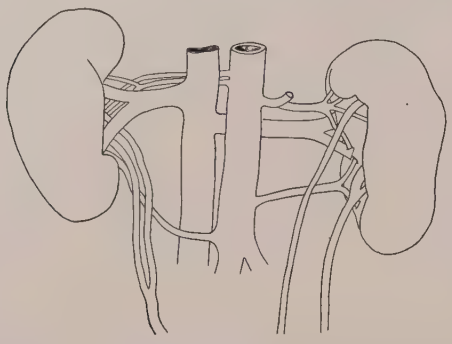

Fig. 517.—Case of multiple renal arteries. After Seldowitsch.

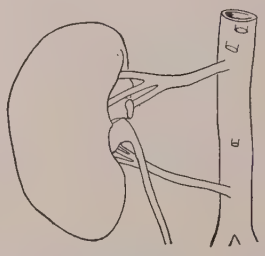

Fig. 518.—Case of multiple renal arteries. After Seldowitsch.

(Figs. 514, 515). The peri-aortic plexus is formed by small branches between the mesonephric and dorsal and ventral segmental arteries, as well as by other smaller

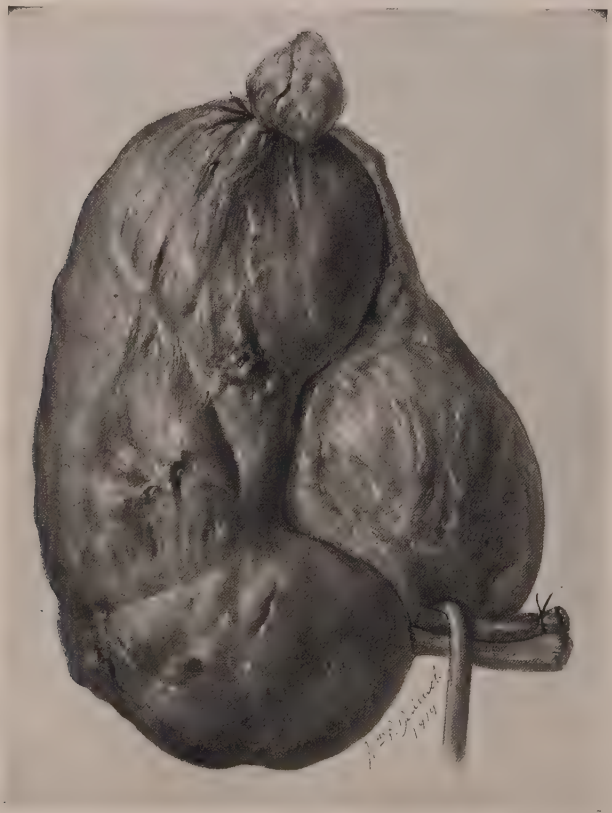

Fig. 519.—Operative specimen showing hydronephrosis. Large aberrant vessels entering the lower pole have pressed upon and kinked the ureter which is normal below this point. B. U. I. 8069.

branches arising from the aorta between these main branches. When the kidney completes its migration certain vessels of this peri-aortic net grow into it. Such

vessels as are particularly favored enlarge and become the main trunks, others less favorably situated degenerate. The selection of the branches which ultimately form the renal arteries is, according to Bremer, mechanical, and varies in different animals because of the variations in the size of the Wolffian bodies and in the curvature of the back. Considering the large number of pathways in the periaortic plexus which are available for the definitive renal arteries, the possibilities for variation are great. Anomalous position of the kidney may be cited as one of the most important causes of variation, but other unexplained mechanical factors and peculiarities of growth must often come into play.

Clinically, anomalous renal vessels are of importance to the surgeon, who should always be on the lookout for them in any operation upon the kidney. Since they may enter the kidney at any point on the surface, care should be taken in freeing the kidney from its fascial attachments; any definite bands of fascia may contain such a vessel, and therefore should be ligated before cutting in order to prevent unnecessary hemorrhage.

The question of anomalous renal arteries giving rise to congenital hydronephrosis has been a much mooted one. This theory, first expressed by Boogard in 1857 (cited from Albarran), holds that the ureter is kinked and constricted by passing over the anomalous artery and results in hydronephrosis (Fig. 519). The view has had numerous adherents and numerous cases of the condition have been reported in the literature. Other observers have been reluctant to accept this hypothesis. In his discussion of this problem Albarran[1] sums up as follows: "Whether the abnormal vessels pass in front or behind the ureter, one is unable to understand how it is able to kink the ureter in order to cause hydronephrosis. On the contrary, a hydronephrotic kidney may descend and the ureter become encroached upon by vessels which cross either in front or behind it."

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C. Anomalies of the Ureter and Pelvis

I. Anomalies in Number.—1. Absence of Ureters.—Abnormalities of the ureters in number bear a close relationship to similar anomalies of the kidneys. Complete bilateral absence of the ureters has been noted in congenital absence of both kidneys. Complete unilateral absence is usually associated with the same condition in the kidney; thus in 272 cases of single kidney collected by Anders[2] the ureter was reported completely absent in 248 and more or less rudimentary in the remaining 24. Complete absence of the ureter is due to an agenesis of the ureteral bud; absence of the kidney, pelvis, and ureteral orifice results from the same cause. In the case of rudimentary ureter with congenital absence of the kidney the condition is attributable to a failure of development of the primitive pelvis and collecting tubules, or to the failure of the metanephrogenic cap. The ureter in such cases is small and may be reduced to a solid cord of tissue; or it may be represented by a blind orifice at the vesical end.

2. Supernumerary Ureter.—Supernumerary or double ureter is one of the most frequent anomalies of the urogenital system and numerous case reports are to be found throughout the literature. The doubling may be complete or incomplete; it may be unilateral or bilateral. Whether complete or incomplete the kidneys associated with double ureters are similar; they may be either double or free supernumerary. In the former the kidney is elongated and is usually constricted at its middle. The constriction may be nothing more than a shallow depression, but in some cases it appears as a deep sulcus. In still fewer cases the two halves of the kidney are held together by only a thin band of renal parenchyma or by connective tissue alone. Even more rarely the two halves of the kidney are completely separated from one another, giving rise to the condition of free supernumerary kidney.

The pelves of the double kidney are usually completely separated from one another, each possessing, however, fewer calices than normal. Cases have been described in which the two ureters spring from a single pelvis. Schwarz[80] reports that the majority of the 68 cases which he collected showed only one pelvis. Considerable doubt exists as to the authenticity of this observation. Papin[74] reports that he has never seen such a case, nor has he found a detailed report of such a case in the literature. In a series of 144 cases of double ureter studied by Braasch and Scholl[52] not a single case of double ureter with single pelvis is mentioned; the condition is likewise not referred to by Kelly and Burnam.[26] Fully reliable evidence of the existence of this condition, therefore, seems to be lacking; if the anomaly is possible, its occurrence is necessarily much rarer than the statement of Schwarz would lead one to believe.

The two pelves of double kidney are always situated one above the other on the mesial surface of the kidney. That of the superior segment is usually smaller than that of the lower, and possesses fewer calices. Braasch and Scholl[52] have found that even in those cases where there is a size difference in the two segments,

the functional capacities of the two are about equal; taken together the function of the two segments is just equal to that of the opposite kidney in spite of the fact that the double kidney is the larger. The distance between the two pelves varies greatly; cases where they are well separated offer the best chance for conservative surgery. The two ureters course downward from the pelves, that from the superior segment usually being mesial to that from the lower, but this relation is by no means constant. The ureters usually lie close together and in many cases are bound together by connective tissue. In some cases they both lie within a common connective-tissue sheath.

In incomplete duplication the two ureters join into a common one at some point between the pelves and the bladder. Papin[74] found the bifurcation in the upper third of the ureter in 13 cases, in the middle third in 16 cases, and in the lower third in 22. Harpster, Brown, and Delcher,[61] in their study of 161 cases of this condition, found the bifurcation most frequently in the lower third of the ureter, the most frequent situation being 3 to 5 cm. from the bladder. Con-

Fig. 520.—Pyelogram showing double kidney and bifid ureter. The bifurcation of the ureter is opposite the third lumbar vertebra. The lower portion of the kidney shows no hydronephrotic changes, but the upper portion is apparently slightly dilated and irregular. This kidney was the seat of a chronic pyelitis. B. U. I. x-Ray 4994.

trary to these findings, Braasch and Scholl[52] found the bifurcation in 100 cases to be most frequently situated in the upper third.

In complete duplication the two ureters course side by side until the bladder is neared, when the ureter from the inferior segment crosses in front of that from the superior segment. Within the bladder the two ureteral orifices vary somewhat in position and in their distance from one another. Most commonly, however, the two orifices lie in a common ureteral ridge, one orifice placed higher and lateral to the other (Fig. 524). An almost constant relation has been noted in regard to the orifices; the ureter from the superior segment of the kidney terminates in the lower ureteral orifice, while that from the inferior segment terminates in the upper orifice.

Still another type of incomplete duplication of the ureter remains to be mentioned, that of a single kidney, pelvis, and ureter above with bifurcation of the ureter below, the two forks forming an inverted ⅄ and terminating in separate ureteral orifices in the bladder. Kapsammer,[66] cited by Harpster, Brown, and Delcher,[61]

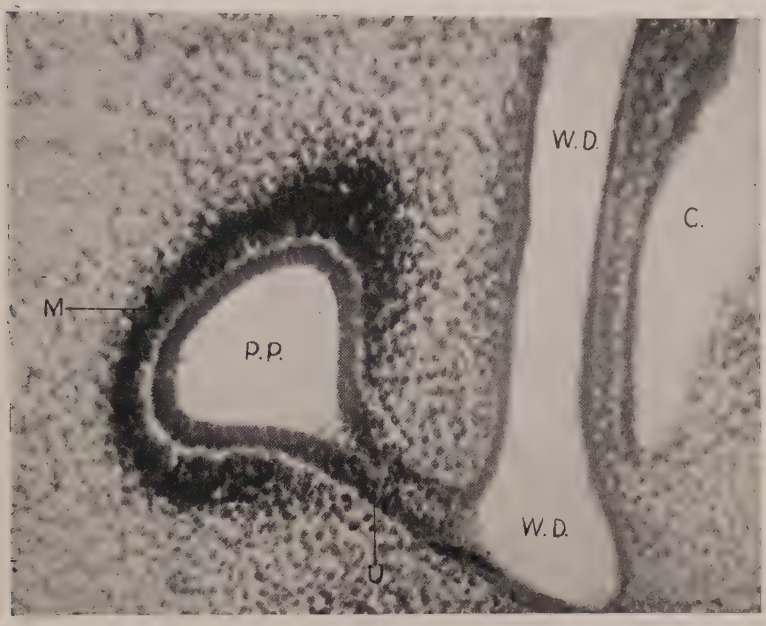


FIG. 521.—Embryology of ureter. Sagittal section through 7.8 mm. human embryo (×240), showing Wolffian duct with its ureteral bud terminating in a bulbous swelling, primitive pelvis. Surrounding latter is zone of metanephrogenic tissue, clearly differentiated from surrounding mesoderm. Embryo Mall 1354, Slide 5, Row 3, Sec. 2.

FIG. 522.—Bifid ureter. Pyelogram showing very clearly the junction of the two divisions of the ureter opposite the third lumbar vertebra. The ureter is single and normal from this point to the bladder. There is a double kidney with two pelves, the lower one apparently normal, but the other one enlarged and occupied by a large calculus.

described a case with four ureteral orifices in the bladder. On the right side the ureters fused into one at a point about 13 cm. from the bladder and entered the kidney through a single ureter and pelvis. On the left side there were two ureters

and pelves. Braasch[6] records the finding of 2 cases in which there was a "division of a single ureter at the brim of the pelvis entering separate meatuses on the same side." Chute[53] states that he has observed a similar case.

From an embryologic point of view complete duplication of the ureter can be explained in either of two ways: (1) It is the result of an early splitting of the

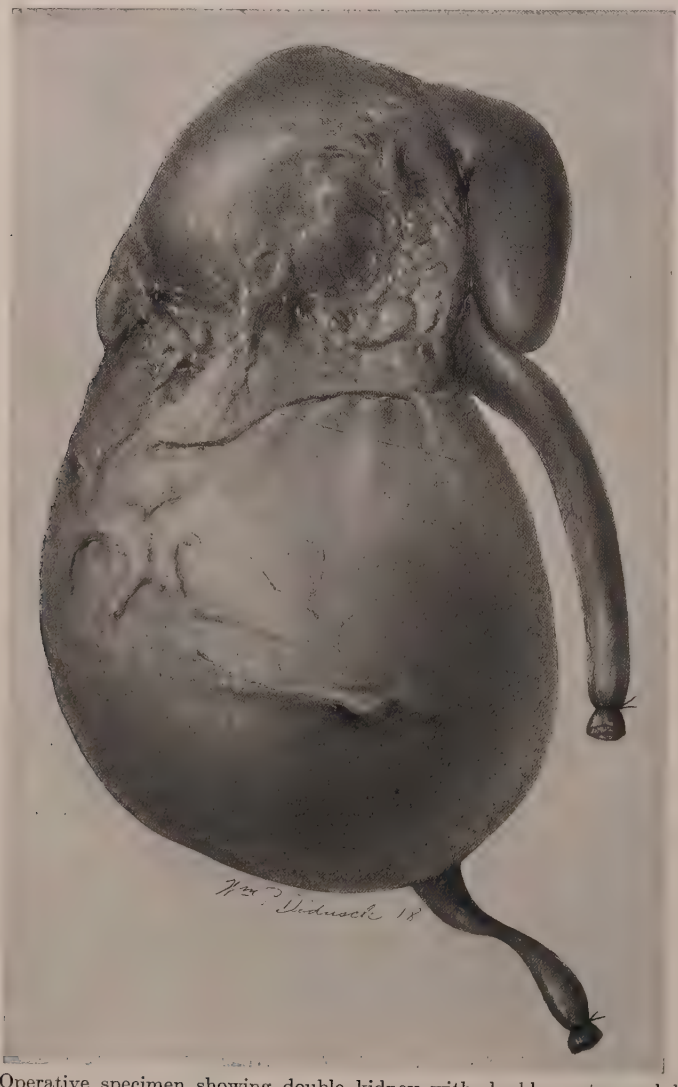


FIG. 523.—Operative specimen showing double kidney with double ureter and hydronephrosis confined to the lower kidney due to obstruction by stricture and kinking of the lower ureter. Upper kidney and ureter normal. B. U. I. 4746.

ureteral bud, or (2) it is the result of the development of two separate anlagen, one above the other, with either a fusion of the metanephrogenic portions (double kidney) or their continued separation (free supernumerary kidney). The first of these views explains not only cases of complete duplication, but incomplete duplication as well. The splitting of the primitive renal pelvis and ureter is from above

downward and may progress to any point. All gradations of incomplete duplication of the ureter are, therefore, explicable on the basis of this view. On the other hand, incomplete duplication cannot be explained by means of two separately developed ureteral anlagen. It would seem, therefore, that the view of the splitting of the ureteral anlage, fitting both conditions, is the more plausible. That complete duplication of the ureter may, however, be brought about by the development of two separate anlagen cannot be denied; in fact, there is strong evidence in its favor. Felix[14] draws a sharp distinction between the incompletely duplicated ureter, which he terms *ureter fissus* or cleft ureter, and *ureter duplex*, or supernumerary ureter. The former he holds is due to a splitting as described above, the latter to two ureteral anlagen. The case of Rech,[76] in which one ureter terminated in the ejaculatory duct and the other in the vas deferens, *i. e.*, the seminal vesicle developing between the two, speaks almost conclusively for two separate renal anlagen. The question cannot be definitely settled, however, until more embryological data is collected. Unfortunately the 2 cases which Pohlman[34] found in embryos of 13 and 25 mm. respectively, were too old to throw any light upon the subject, since

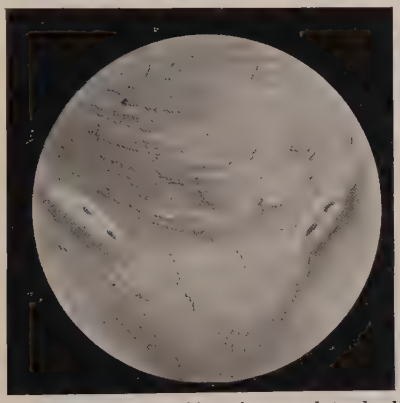


Fig. 524.—The usual position of the ureteral orifices in complete duplication of the ureters. The inferior orifices belong to the ureters from the upper segments of the kidneys. After Moore.[72]

in both cases the two ureters had already acquired separate orifices in the vesico-urethral anlagen. At the present time, therefore, we can only conclude that incomplete duplication is definitely the result of a cleavage process; that complete duplication may sometimes be the result of cleavage, at other times the result of the development of two separate anlagen.

Still another view is expressed by Huntington[63] in explanation of a case of incomplete duplication of the ureter which he reported. The case was one in which one ureter terminated in a normal pelvis with a complete complement of primary and secondary calices, the other, in an incomplete pelvis. He argues against the splitting process in this case inasmuch as the normal pelvis was complete, and considers that the incomplete pelvis must have arisen as a lateral sprout from the normal ureter.

The position of the ureteral orifices in complete duplication is readily explained by a study of the normal development. As seen in Fig. 486 the ureter has its origin from the lower portion of the Wolffian duct. With continued development the terminal portion of the Wolffian duct is absorbed into the vesico-urethral an-

lage, so that both Wolffian duct and ureter acquire separate openings. By a peculiar process of growth the ureteral orifice is shifted cranially and laterally. When two ureters are present on one side, the one from the inferior half of the kidney is placed lower on the Wolffian duct than that from the superior half (Fig. 525). With the absorption of the Wolffian duct the inferior ureteral orifice reaches the vesico-urethral anlage first and begins its upward and lateral shifting, while the ureter from the superior segment of the kidney is still attached to the Wolffian duct. The latter, in turn, reaches the vesico-urethral anlage and begins its upward and lateral shifting, but never reaches as high a level as the first. In the adult, therefore, the ureter from the inferior segment crosses in front of that from the superior segment and implants itself at a higher level (Fig. 525). Occasionally the ureter from the superior segment does not reach the bladder, but remains attached to the Wolffian duct or urethra. Such cases constitute an interesting group of

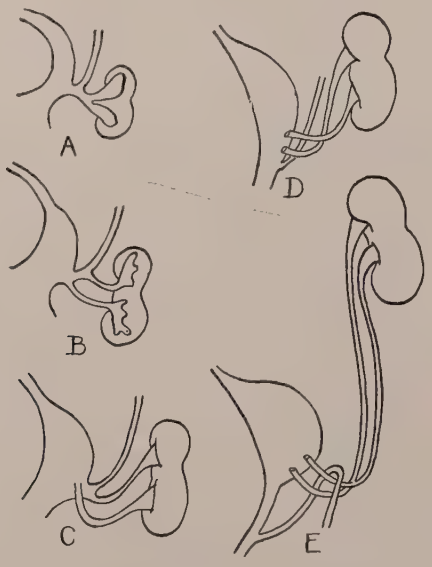


Fig. 525.—Diagrams showing cleavage theory in complete ureteral duplication and why it is that the superior ureteral orifice belongs to the ureter from the inferior segment of the double kidney. Lettered in order of development.

anomalies which are described below under the heading of Abnormal Implantations of the Ureter.

The frequency of duplication of the ureter, both complete and incomplete has been estimated from autopsy findings as follows: Bostroem[50] 3 per cent., Poirier[75] 4 per cent., Wagner[82] 3 per cent. Mauclaire and Sejournet[69] find that it occurs oftener in the female than in the male in the ratio of 7 to 3. This proportion is somewhat higher than that obtained by Harpster, Brown, and Delcher,[61] 86 females to 65 males. The latter authors have recently collected 382 cases of complete and incomplete doubling of the ureter. Of these, complete doubling occurred in 221 (58.1 per cent.); it was bilateral in 40 cases (18 per cent.) and unilateral in 181 (82 per cent.). Of the latter there were 10 cases of free supernumerary kidney (5.5 per cent.) and 171 (94.5 per cent.) of fused or double kidney. Of the 161 cases of incomplete doubling the condition was bilateral in 28 (17.4 per cent.), unilateral in 133 (82.6 per cent.), and of the latter there were 9 cases of free super-

numerary kidney. Of the unilateral cases where the side was mentioned, both complete and incomplete, the condition was found on the right side in 94 (47 per cent.) and on the left in 108 (53 per cent.). Of a series of 144 cases of duplication of the ureter reported by Braasch and Scholl,[52] 44 (30 per cent.) were complete and 100 (70 per cent.) incomplete; of the former the condition was bilateral in 8 cases (18 per cent.) and unilateral in 36 (82 per cent.); of the incomplete cases only 1 (1 per cent.) was bilateral. Such wide variations in the above results emphasize the importance of the collection of a still larger number of cases before these percentages can be regarded as of any statistical value.

Most cases of duplication of the ureter are of no clinical importance, that is, they do not give rise to symptoms *per se*, and they are only brought to notice as accidental autopsy findings, or clinically because of some coexisting pathologic process. Statistics have shown, however, that congenital anomalies of the kidneys and ureters are especially prone to pathologic change. Because of this and because of the comparative frequency of duplication of the ureter the urologist should always be on the lookout for such cases. In complete duplication three ureteral orifices should be found in the bladder on cystoscopic examination, yet when the condition is unsuspected it is easy to understand how the presence of an accessory ureteral orifice might be overlooked.

Pyelography offers the surest means of diagnosis. *If the x-ray shadow shows a small incomplete pelvis in either the upper or lower half of the elongated kidney the presence of a second ureter and pelvis should be at once suspected.* Search for a second ureteral orifice should then be made, and if found, the supernumerary ureter should be catheterized and pyelograms of both pelves made. Braasch and Scholl[52] suggest for those cases where there is a supernumerary ureteral orifice present, that after the catheterization of one ureter the cystoscope be withdrawn and repassed through the urethra alongside of the ureteral catheter, and the remaining two ureters be catheterized. In order to obviate the withdrawal of the cystoscope however, they have constructed and described a special catheterizing barrel which takes three catheters at once, thus simplifying the task. The Wappler operating cystoscope will carry three or four small catheters simultaneously through the large catheter channel.

In incomplete duplication of the ureter, where there is a single orifice in the bladder, the diagnosis usually becomes evident as an accidental finding during pyelography. The ureteral catheter reaching the fork of the ureter passes up to either the superior or inferior pelvis. When the opaque solution is injected it not only fills the pelvis in which the tip of the catheter lies, but it runs downward along the catheter and up into the other pelvis, thus filling them both. This has been the experience of many who have diagnosed the condition preoperatively. In cases where the solution fails to flow into the second pelvis the presence of an incomplete pelvis in either half of the kidney must be relied upon for the diagnosis. Braasch and Scholl[52] suggest, as a routine measure in the making of pyelograms, that before the complete withdrawal of the catheter a second injection be made in order to fill both branches of a bifurcated ureter should they be present.

As stated above, a kidney with double pelvis and ureter seems to be more susceptible to disease than a single kidney. Mertz,[71] in a series of 300 collected cases, found 80, or about 27 per cent., suffering from renal pathologic changes in addition to the anomaly. In 144 cases Braasch and Scholl[52] found 54, or 37.5 per cent., with

pathologic complications, the higher percentage here being due to the fact that all were clinical cases. (Healthy people with double ureters do not often come to examination.) The latter authors found both segments most often affected by the disease, but in those cases where only one segment was involved it was more often the lower; this observation is confirmed by the studies of Eisendrath.[55] Among the pathologic lesions complicating double kidney and ureter in the order of their frequency are renal infections, renal and ureteral calculi, hydro- and pyonephrosis due to ureteral obstruction, renal tuberculosis, essential hematuria, nephroptosis, neoplasms, and ectopic implantation of the supernumerary ureter.

3. Multiple Ureters and Pelves.—Duplication of the renal pelvis is the rule in duplication of the ureter. It is not uncommon, however, to find a split pelvis, the two halves of which unite close to the kidney; Kelly and Burnam[26] and Braasch and Scholl[52] figure several cases of this type. Such pelves are always

Fig. 526.—Three separate pelves leading into a common ureter. After Braasch and Scholl.[52]

Fig. 527.—Case of double kidney and ureter, incomplete. The superior segment of the kidney is small, but has 5 calyces (or ureters) leading into a single ureter. The two main ureters are twisted below. After Fürstner, cited by Eisendrath.[55]

extrarenal; they represent a lesser degree of duplication than double ureter, but belong to the same category. In addition, cases have been reported in which more than two branches leave the kidney to unite in a single ureter (Figs. 526, 527). An interesting case is reported by Richmond[78] in which four "ureters" were discovered emerging from the hilus of each kidney. They united at a point 4 inches from the bladder to form a pelvis from which sprang the ureter proper. There was no pelvis within the hilus, but the calices united to form infundibula, of which these ureters seemed to be the continuation.

II. **Anomalies of Position.**—Anomalies in the position of the ureter are not of infrequent occurrence. In most cases they are associated with anomalies of the kidneys, fusion forms of various types, ectopic kidneys, double and supernumerary kidneys, etc. One of the most unusual types is found in crossed dystopia, in which the ureter crosses the midline of the body. This condition has been described above.

An interesting anomaly has recently been studied by Graves and Davidoff[60] in which the ureter courses downward from the renal pelvis, passes medially behind the vena cava inferior, hooks around this vein anteriorly to attach itself to the bladder at the usual site. The anomaly was found several times in the cat by these authors. They cite cases in man by Hochstetter,[62] Kolisko,[68] and Gladstone.[59] The condition is dependent upon a malformation of that portion of the vena cava which has its origin from the posterior cardinal and subcardinal veins, rather than to a defect in the development of the ureter.

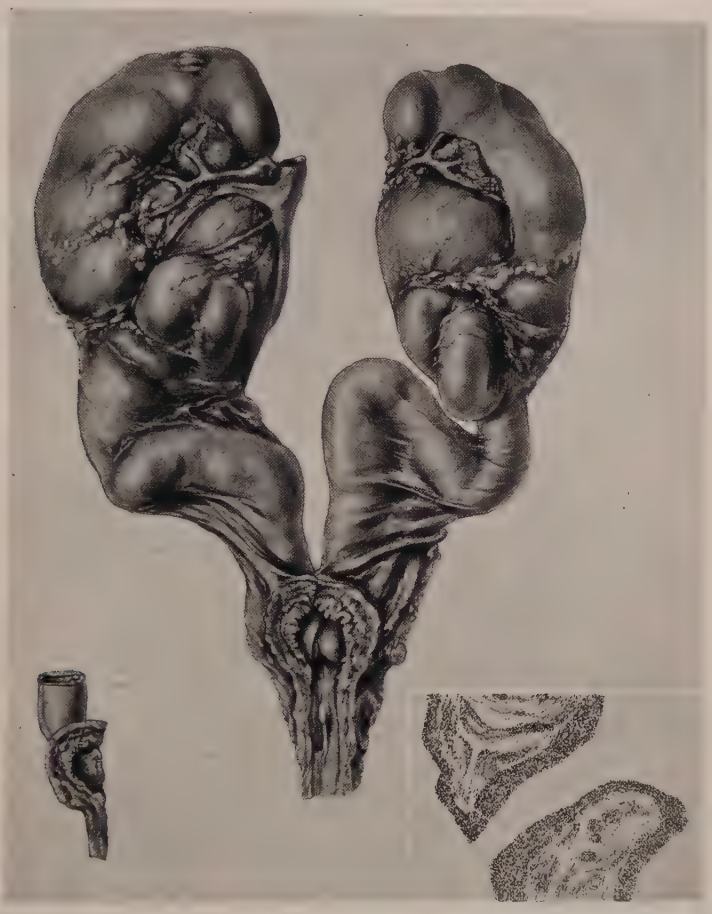


FIG. 528.—Autopsy specimen from an infant showing very marked bilateral hydronephrosis and hydro-ureter due to bilateral congenital strictures of the ureterovesical orifices. The microscopic drawing of one of these pin-point orifices is shown in the lower right-hand corner. Note the absence of inflammatory change. Courtesy of Dr. M. C. Winternitz.

III. **Anomalies of the Ureteral Lumen.**—*Strictures* and *stenoses* of the ureter may be either congenital or acquired, but in many cases it is difficult to make this distinction. Bottomley[51] has collected 56 cases of congenital stricture from the literature. The majority of cases were found at the extremes of life, under five years and over sixty. Of those cases in which the sex was noted there were 25 males and 16 females. There were 11 cases in which the ureter was doubled. The size and form of the stricture varies greatly; it may be a sharply defined constriction or may be from $\frac{1}{4}$ inch to 4 inches in length. It may be permeable or impermeable.

Above the stricture the ureter may be small, or it may be dilated to the size of an intestine. It often presents kinks and folds. The stricture may occur at any point along the course of the ureter, but the most common site is near the bladder (Figs. 528, 529). In Bottomley's collected cases 8 were in the upper third of the ureter and 36 at the bladder end.

The effect of *congenital stricture* upon the kidney may be either atrophy or hydronephrosis. When atrophy occurs the kidney may be reduced to a small inconspicuous fibrous mass, a condition which has led to the erroneous diagnosis

Fig. 529.—Autopsy case, newborn male infant, showing unilateral hydro-ureter and hydronephrosis due to congenital stricture of the intramural portion of the ureter. The stricture was fibrotic, but there were no definite signs of inflammation. Courtesy of Dr. Guy L. Hunner and Dr. Lawrence R. Wharton.

of congenital absence of the kidney. Cases in which hydronephrosis results are more striking. All grades of the condition have been found.

Congenital stricture may or may not give rise to symptoms; when these occur they come on insidiously, sometimes not presenting until late in life. The symptoms are usually temporary, with recurrent attacks of hematuria, pain, and urinary frequency. In a case recently seen at the Brady Clinic (B. U. I. 11,148) the patient, a healthy young man of twenty-five years, showed no symptoms until one week before the diagnosis was made. He then began to have attacks of renal pain with hematuria. Ureteral catheterization showed a functionless kidney on the

left side; a pyelogram showed an extensive hydronephrosis. At operation the kidney was found to be reduced to a thin-walled sac of large size. Examination of the ureter showed a stricture $\frac{1}{2}$ inch in length at the ureteropelvic junction (Fig. 530).

Strictures not infrequently give rise to *cystic dilatations of the ureter*. These may occur at either the upper or lower ends of the ureter; the latter may be either intra- or extravesical. Cystic dilatations at the upper end of the ureter are associated with atrophic kidneys and the cyst marks the position of the renal pelvis. Two cases of this type are cited by Delmas and Delmas.[54]

Intravesical cysts of the ureter are the result of strictures at the ureteral orifice. The lower end of the ureter becomes dilated and bulges into the bladder, pushing the bladder mucosa before it. Such cysts vary in size from that of a grape to one almost completely filling the bladder cavity; a few cases are on record where the cysts pushed through the urethra in the female and presented at the external

FIG. 530.—Section from the ureter in a case of unilateral hydronephrosis developing in a young, healthy man. There is no sign of inflammation, but the ureteral lumen is very markedly diminished. This is undoubtedly a case of congenital stricture at the ureteropelvic junction. B. U. I. Path. 4578.

urethral orifice. The case of Blumer[49] showed this condition to be bilateral, with a large cyst on the left and a smaller one on the right (Fig. 531). Our case[84] was observed at cystoscopic examination, the cyst rapidly filling with each peristaltic flow of urine down the ureter, and slowly emptying and flattening out between peristaltic waves. A case similar to this was described by Kelly[67] which was relieved by the simple procedure of enlarging the ureteral orifice.

The question of whether these cysts are of congenital origin is discussed by Blumer.[49] Of the 13 cases which he collected there was definite evidence of a congenital origin in 10, in 5 death occurred in early childhood.

Extravesical cysts are due usually to a blind termination of the lower end of the ureter, but all blind terminations do not produce cysts. These cases have usually been described under the heading of abnormal terminations of the ureter, and are placed in the same category with those cases of abnormal implantation of the ureter in the urethra, seminal vesicle, etc. They are, however, the results

of complete atresia with the loss of the lower end of the ureter. The ureteral bud must have developed in the normal manner as an outbudding from the Wolffian duct. Either before or after the orifice shifts to the bladder atresia occurs and the lower end of the ureter becomes detached from its orifice. The process is, then, an exaggeration of that which gives rise to congenital stricture. In these cases the end of the ureter is usually found lateral to the bladder, but it may be either posterior or inferior to it; in certain cases the ureter terminates blindly in the outer coats of the bladder wall. Schwarz[80] has collected 23 cases of this anomaly from the literature, of which 8 were of supernumerary ureter.

The following case is of exceptional interest since it presents both double ureter and obstruction with intravesical cyst formation:

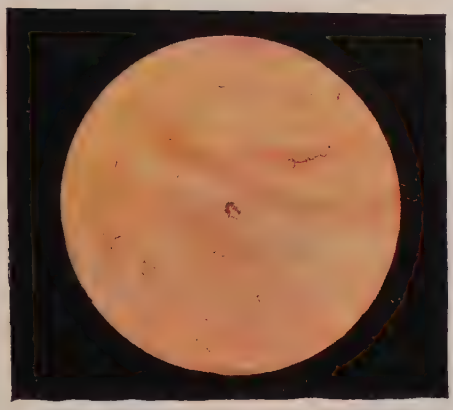
B. U. I. 3010, C. A. C.; age thirty-two years. Admitted November 9, 1911, complaining of dull pain in left side of abdomen and cloudy urine. As long as he could remember

Fig. 531.—Bilateral intravesical cysts of the lower ends of the ureters due to congenital stricture at the ureteral orifices. The left ureteral orifice cannot be seen as it lies on the posterior surface of the cyst. After Blumer.[49]

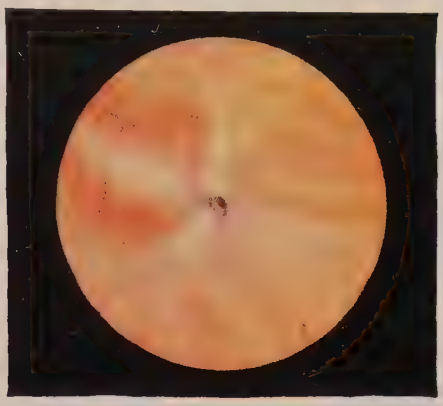
he had had a feeling of discomfort and slight, dull pain in left half of the abdomen. Urination had always been normal; and, on examination, the prostate felt normal. There was no residual urine. Bladder capacity was normal. With the cystoscope study of the prostatic orifice was negative. No bar or lobe. The right ureteral orifice was normal in appearance. On the left side, where the ureter should be, an orifice of a diverticulum about 1 by 2 cm. in size was seen. It was evident that the ureter lay within this diverticulum. While viewing this region with the cystoscope, patient had a strong desire to urinate, accompanied by abdominal straining; and immediately out of the orifice of the diverticulum came a bulging mass of mucous membrane, which formed a globular intravesical tumor about the size of a pear. This was smooth and apparently markedly distended. While watching this from the inner surface, a small jet of fluid escaped and flowed continuously. This was made out to be the orifice of the ureter from which the urine was escaping. After a time the abdominal spasm disappeared; and, after increasing the fluid in the bladder, the rounded tumor mass suddenly disappeared through the orifice of the diverticulum, carrying with it the ureteral orifice. On command patient could, by making abdominal pressure, cause the mass to bulge out into the bladder or retract into a diverticulum at will. The right ureter was easily catheterized. The left ureter could only be catheterized when the tumor mass was in the bladder and then only by using a No. 6 catheter. When the catheter was pushed upward the mucous membrane went with it and the intravesical balloon disappeared.

PLATE XVIII

ABNORMALITIES OF URETERAL ORIFICE

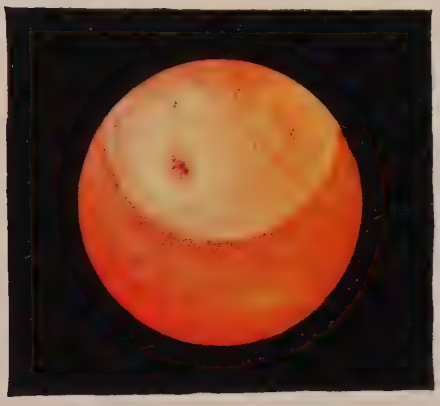


A. Small calculus caught in right ureteral orifice. B. U. I. 5401.



B. Same case (A). Jet of urine escaping on each side of calculus. B. U. I. 5401.

C. Intravesical balloon of lower end of ureter—empty. B. U. I. 10,742.



D. Same case (C). Intravesical ureteral balloon distended as seen intermittently. B. U. I. 10,742.

E. Double ureteral orifices on left side.

F. Catheterization of same case.

Examination of the separated urines was as follows:

TABLE 139

			Phenolsulphonephthalein.			
Color.	White blood-cells.	Bacteria.	Amount.	Appearance time.	Period.	P. S. P. per cent.
Right clear.....	0	0	30 c.c.	10 min.	30 min.	11 per cent.
Left cloudy.....	++	++	177 c.c.	25 min.	30 min.	Trace

A catheter in the bladder during the collection showed that 10 per cent. phthalein had escaped, supposedly around the catheters into the bladder. Collargol, 15 per cent., was then injected through each catheter and radiographs were taken. These showed moderate hydro-

FIG. 532.—The three ureters have been catheterized, thorium nitrate injected, and pyelograms made. Right side hydronephrosis. Left side double kidney, two pelves, two ureters with great dilatation of lower end of inner ureter which bulges into bladder (intravesical balloon). Marked dilatation of lower portion of inner ureter.

nephrosis on the right side, and a large dilated ureter immediately above the bladder on the left. Collargol had not reached the kidney. As a preliminary procedure it was determined to carry out intravesical diverticulectomy and bring the ureteral orifice into the bladder, closing the wound, as described elsewhere.

Operation (Young): As soon as the bladder had been opened an intravesical balloon 1½ inch in diameter was found. On its inner surface the orifice of the left ureter was seen. Into this a filiform was introduced, followed by a dilator, after which a large amount of fluid stained with collargol escaped. Further examination of the intravesical balloon showed on the outer side another ureteral orifice at a point about 5 mm. from where it joined the level of the bladder wall on the outer side. This orifice was quite normal in appearance, being in the form of an oval slit, and a catheter passed into it for a distance of 30 cm. Examination showed that the outer ureter was not dilated, but the inner ureter was very greatly dilated, as previously shown by ureterogram, forming practically all of the intravesical balloon above referred to, and dragging into the bladder the orifice of the second left ureter. After considering the question carefully we decided to enlarge the constricted orifice of the inner left ureter and close the diverticular opening after excising the mucous membrane covering the intravesical portion. This was carried out without difficulty, the denuded edges of the bladder muscle being brought together with catgut sutures to close the diverticular orifice. This left both ureteral orifices on a level with the surrounding vesical mucosa and cured both the diverticulum and the intravesical balloon. Before closing the bladder catheters were inserted into the two ureters on the left side. Subsequently pyelograms were taken, which showed marked dilatation of the inner ureter and of the upper pelvis of what was evidently a double kidney and a slight dilatation of the lower outer pelvis (Fig. 532). Convalescence was uneventful. The patient was seen on numerous occasions. December 30, 1911, cystoscopy; no residual urine. Right ureteral orifice normal, but in the left half of the bladder the mucous membrane is slightly irregular. No diverticulum present, and, on straining, no tumor.

Fig. 533.—Congenital ureteral valves. After Zuckerkandl.[85]

March 6, 1913: Urine still cloudy. Cystoscopic study of the left side of the bladder shows irregular mucous membrane in region of operation. No intravesical ballooning even on abdominal pressure. The orifice of the inner ureter can be seen. The external orifice is not visible.

December, 1919: All three ureters catheterized. The urine from the right ureter contains pus and bacilli; urine of good quality. Urine from the inner left ureter is cloudy, pale, and of poor quality. The urine from the outer left ureter is free from infection and of good quality. Patient was given a series of pelvic lavages for the right ureter and inner left ureter.

June 5, 1920: Now no symptoms referable to his kidney, but the urine is still cloudy.

The cause of congenital stricture of the ureter is not well understood. Bottomley states that they are either the "result of a primary defect, the arrest of an earlier embryonic stage, or of a secondary retrogressive metamorphosis." They are undoubtedly secondary, but the actual cause of their formation has never been determined. They are probably similar in nature to congenital strictures and atresias found in other organs of the body, esophagus, intestine, anus, etc. It has been claimed that those in the upper part of the ureter are caused by the pressure of anomalous renal vessels, but, as Albarran[1] states, this view is hardly tenable.

In addition to strictures of the ureter mention should be made of kinks and valves. The former are seen in cases of nephroptosis, ectopic kidney, horseshoe kidney, and other fusion forms. They may occur at any point where the ureter bends over an anomalous blood-vessel, but what is cause and what effect here is still a disputed question.

Fig. 534.—J. H. H. Gyn. Section showing hydro-ureter due to congenital ureteral valve. This was a case of supernumerary kidney and ureter, the kidney being above the normal left kidney, and the ureter opening into the vagina. The ureter was resected and tied, with complete recovery. Courtesy of Dr. Guy L. Hunner and Dr. Lawrence R. Wharton.

Fig. 535.—J. H. H. Gyn. Same case as previous picture. External view and section of gross specimen removed. Courtesy of Dr. Guy L. Hunner and Dr. Lawrence R. Wharton.

Valvular formations in the upper portion of the ureter have been described as a cause of hydronephrosis (Figs. 533–535). The so-called "ureteral valves" are merely duplications of the ureteral mucosa; bands of the muscularis which are contained in the folds tend to make them stand out more prominently. Wölfler[83]

studied the ureters in 100 newborn children, and in 20 found more or less definite cross-folds of the ureteral mucosa. They have been observed by Englisch[56] in human embryos of four months. Motzfeld, in a series of 21 cases of hydronephrosis, attributes 9 of them to ureteral valves.

IV. **Anomalies of Implantation.**—Under this heading are included those cases in which the ureteral orifice is found in some organ other than the bladder. Numerous case reports of this anomaly are to be found in the literature. In many cases the abnormally terminating ureter is a supernumerary one. From an embryologic point of view three distinct types of cases are to be distinguished:

1. Cases due to the maldevelopment of the urorectal septum, including terminations in the cloaca and rectum.

2. Cases due to the failure of the normal shifting of the ureter, comprising terminations in the male and female urethra, ejaculatory ducts, seminal vesicles, vasa deferentia, vestibule of the vagina, and Gärtner's canal.

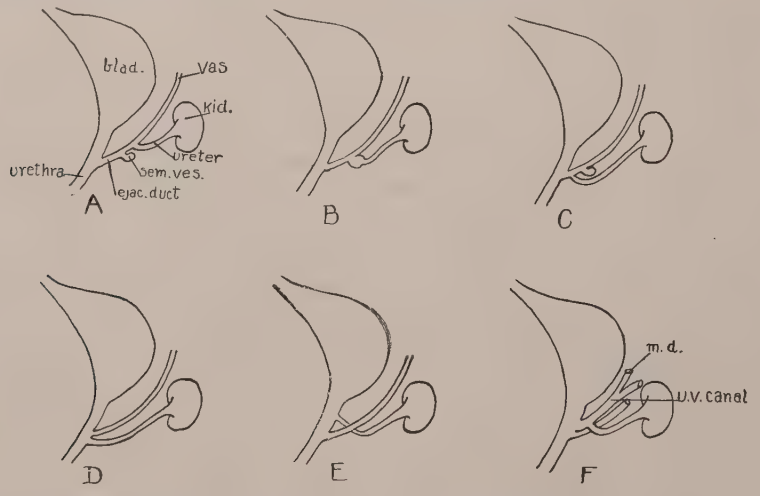


FIG. 536.—Diagrams to show anomalous termination of ureter: A, in vas deferens; B, in seminal vesicle; C, in ejaculatory duct; D, in urethra at level of verumontanum; E, in urethra above veru; F, in vagina or utriculus masculinus: *m.d.*, Müllerian duct; *u.v.*, uterovaginal canal.

3. Cases due to an abnormal shifting of the ureteral orifice, comprising terminations in the prostatic utricle, vagina, uterus, and Fallopian tubes.

1. MALDEVELOPMENT OF THE URORECTAL SEPTUM.—Schwarz has collected 3 cases in which the ureter terminated in the rectum and cloaca, and Otto (cited by Delmas and Delmas[54]) 4 cases of monsters in which the termination was in the cloaca. The anomaly is due to the failure of the normal division of the cloaca into the rectal and vesico-urethral portions. If the division fails completely the ureter will be found ending in the cloaca; if the urorectal septum develops in such a way as to include the orifice of the Wolffian duct in the rectal portion, the ureter will be found terminating in the rectum. The anomaly is usually associated with other serious developmental defects. Because of the marked pyonephrosis set up in these cases the anomaly is not compatible with life.

2. FAILURE OF THE NORMAL SHIFTING OF THE URETERAL ORIFICE.—Under normal conditions the terminal portion of the Wolffian duct is absorbed and both it and the ureter come to acquire separate openings in the vesico-urethral anlage (Fig. 489).

The ureteral orifice then begins a craniolateral shifting, and by the time the demarcation between the bladder and the urethra becomes apparent the ureter has reached its adult position in the bladder portion. If this absorption and shifting fails, wholly or in part, an anomaly in the position of the ureteral orifice results. Long after the ureter has reached its normal definitive position, a second outbudding from the lower end of the Wolffian duct develops and gives rise to the seminal vesicle. The anlage of the seminal vesicle, therefore, occupies a higher position on the Wolffian duct than does the ureter (Fig. 536). In those cases in which the ureter terminates in the vas deferens we must assume not only a failure of the normal shifting of the ureteral orifice, but a faulty relationship between the anlagen of the ureter and seminal vesicle as well; either the ureteral bud has developed at a higher level on the Wolffian duct, or the seminal vesicle at a lower level, than normal. In those cases where the ureter empties into the seminal vesicle the ureteral bud must have developed from that portion of the Wolffian duct which later would have given rise to the seminal vesicle. If the anomaly is merely one of failure of the shifting process, the ureteral orifice will be found in the ejaculatory duct or the urethra, depending upon the degree of failure. In the female complete failure of the shifting process leaves the ureter attached to the lower remnant of the Wolffian duct, Gärtner's canal, partial failure to the vestibule or the urethra.

Ureter Terminating in Vas Deferens.—Five cases of this type have been collected by Delmas and Delmas.[54] In 4 of these cases mention is made of other developmental defects as well, absence of kidney of opposite side, non-union of the pubes, imperforate anus, etc. In one the abnormally ending ureter was a supernumerary one. The cases ranged in age from a fetus to fifty years old. A recent case has been described by Rech[76] of a man of sixty-nine years of age with double kidney and ureter on the left side. One of these ureters terminated in the vas deferens, the other in the ejaculatory duct.

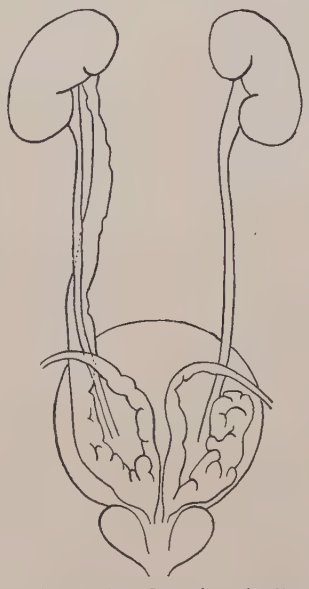


Fig. 537.—Complete duplication of the ureter with termination of the ureter from the superior segment in seminal vesicle. After Hoffman, cited by Eisendrath.[55]

Ureter Terminating in Seminal Vesicle.—Delmas and Delmas have collected 4 cases of this condition. In 2 of these cases the left kidney was absent, the left ureter terminating in the left seminal vesicle. In only 1 case was the ureter supernumerary. Six cases of the same type were collected by Schwarz.[80] The case of Hoffman is shown in Fig. 537.

Ureter Terminating in Ejaculatory Duct.—Four cases of this anomaly have been collected by Schwarz. In this condition the ureter traverses the substance of the prostate to terminate in the ejaculatory duct.

Ureter Terminating in the Male Urethra.—This anomaly is more frequent than any of the foregoing. Of the 10 cases collected by Schwarz, 7 were of supernumerary ureter. The opening is always found in the prostatic urethra. The 11 cases cited by Delmas and Delmas show that the orifice is most frequently found at the level of the verumontanum, 8 cases, but in 2 cases it was found above it and in 1 below

it. In the male termination of the ureter in the urethra does not give rise to incontinence, as in all cases the orifice lies above the external sphincter.

Ureter Terminating in the Female Urethra.—Delmas and Delmas have collected 7 cases of this type. The ureteral orifice may be located at any point between the bladder neck and the external meatus. The condition is of more clinical interest than in the male, as it is apt to give rise to incontinence of urine. Four of the 7 cases of Delmas and Delmas had incontinence. Of the 5 cases studied by Schwarz the abnormally terminating ureter in 3 was supernumerary. Kelly and Burnam[26] have reviewed a number of these cases and have added 2 more which came under their personal observation.

Ureter Terminating in the Vestibule.—Cases of this nature are more common than the above; Schwarz records 10 cases, 2 of which were of supernumerary ureter. The ureteral orifice usually lies close to the external urethral meatus, sometimes below it, sometimes lateral. The condition corresponds to that in the male in which the ureter terminates in the urethra at the level of the verumontanum or below it. These cases frequently but not invariably give rise to incontinence. Furniss[58] describes a case of this type and has reviewed the operative treatment for the cure of the incontinence.

Ureter Terminating in Gärtner's Canal.—Tangl (cited by Kelly and Burnam) reports 1 case of this type. There was congenital atrophy and dystopia of the left kidney, the left ureter opening into a persistent Gärtner's canal. From an embryologic viewpoint the case corresponds in the male to the opening in the vas deferens or ejaculatory duct.

3. Abnormal Shifting of Ureteral Orifice.—Normally the ureter completes its shifting process shortly before the fused Müllerian ducts join the vesico-urethral anlage. Into the posterior wall of this anlage an invagination develops which is known as Müller's hillock. Still later the fused Müllerian ducts grow downward and unite with the hillock. The resultant tube is known as the uterovaginal canal, and it gives rise to the vagina and uterus in the female, to the utriculus masculinus in the male. It lies between the two Wolffian ducts. It is easy to perceive, therefore, that when the shifting of the ureter is late or incomplete it is liable to be carried out on the uterovaginal canal (Fig. 536, F).

Of these anomalies the opening of the ureter into the vagina is the most common. Kelly and Burnam have collected 8 cases of this nature, the abnormally terminating ureter being supernumerary in 3. Such cases give rise to a constant dribbling of urine and are of considerable interest from a surgical standpoint. A recent case of this type is reported by Samuels, Kern, and Sachs,[79] the ureter being supernumerary. (See Fig. 534.)

Cases of the ureter terminating in the uterus and Fallopian tube are reported by Veau[81] in non-viable monsters with many other anomalies. Cases in which a supernumerary ureter terminated in the utriculus masculinus have been recorded by Remy[77] and Bostroem.[50] A case is reported by Eppinger[57] of a male pseudohermaphrodite of fifty-two years in whom the right ureter emptied into the uterovaginal canal.

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D. Bladder

Development of the Bladder.—The bladder has its formation principally from the entoderm of the caudal region of the embryo. If we review the structure of some of the youngest known human embryos we find the primitive entoderm in the form of a hollow vesicle, the *yolk sac.* As the neural folds are developing on its "upper" surface, there grows out from the yolk sac into the primitive umbilical stalk a small tube-like structure, the *allantois* (Fig. 538, left). A little later the foregut and tail gut are formed as evaginations from the same sac (Fig. 538, right), but the allantois in the human embryo is the first to form. With the formation of the hindgut and the relative narrowing of the opening of the *yolk stalk,* the hindgut and the allantois come to open into a common pouch, the cloaca. The

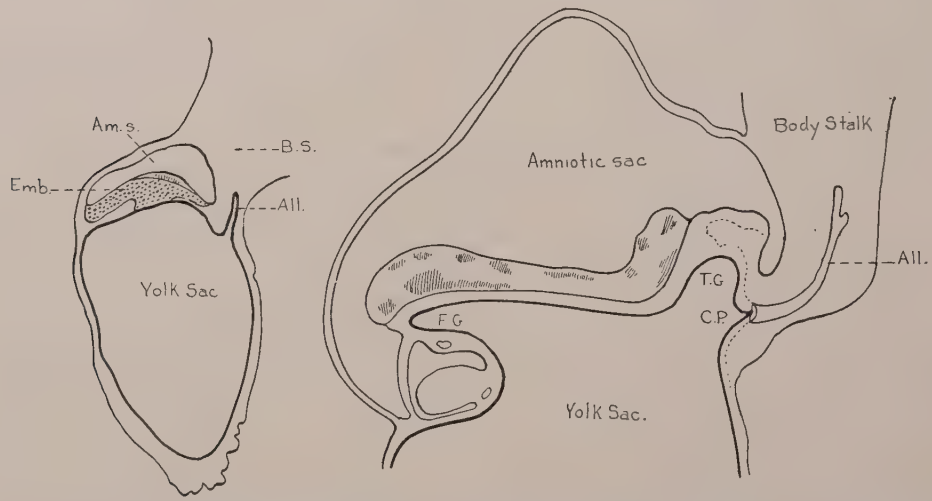

Fig. 538.—Left, median section of Minot's embryo, showing origin of the allantois from the primitive yolk sac. *All.*, allantois; *Am.s.*, amniotic sac; *B.s.*, body stalk; *emb.*, body of embryo. Right, median sagittal section of Dandy's embryo, showing the further growth of the allantois and the formation of the cloaca. *All.*, allantois; *C.P.*, cloaca; *F.G.*, foregut; *T.G.*, tail gut. After Lewis.[112]

ventral wall of the cloaca very early comes in contact with the outside ectoderm and its cavity is separated from the outside by only a double layer of epithelium, the *cloacal membrane* (Fig. 547). The primary excretory duct, developing by the fusion of the pronephric tubules, grows downward and joins the cloaca. It later serves as the excretory duct for the mesonephros, when it becomes known as the Wolffian duct. From this, as has been described above, the anlage of the permanent kidney has its origin.

The *urorectal septum,* developing from above downward and lying in the frontal plane, gradually divides the cloaca into two portions, the posterior, which is the rectum, and an anterior, the vesico-urethral anlage. The cloacal membrane is likewise divided and its halves form the anal and urogenital membranes. The upper part of the vesico-urethral anlage enlarges to form the bladder; at its apex it receives the allantois. The manner in which the lower portion of the Wolffian duct is gradually rolled into and absorbed by the vesico-urethral anlage has been

already described. By this process the ureter comes to open directly into the vesico-urethral anlage and the position of its orifice is gradually shifted to a point lateral to and above the orifice of the Wolffian duct. It will be remembered that the Wolffian duct is of mesodermal origin, and since a portion of the Wolffian duct is absorbed into the bladder and urethra, a small area of these structures is, therefore, a derivative of the mesoderm. This area is not circumscribed or clearly defined, but corresponds closely with the trigone. The remainder of the bladder lining is of entodermal origin. The connective tissue and muscular coats are added by a differentiation of the surrounding mesenchyme.

The allantois undergoes regressive changes; it loses its lumen and is reduced to a solid cord of connective tissue connecting the apex of the bladder with the umbilicus; in this manner it is converted into the urachus. In its course it lies between the two obliterated hypogastric arteries laterally, and just anterior to the parietal peritoneum.

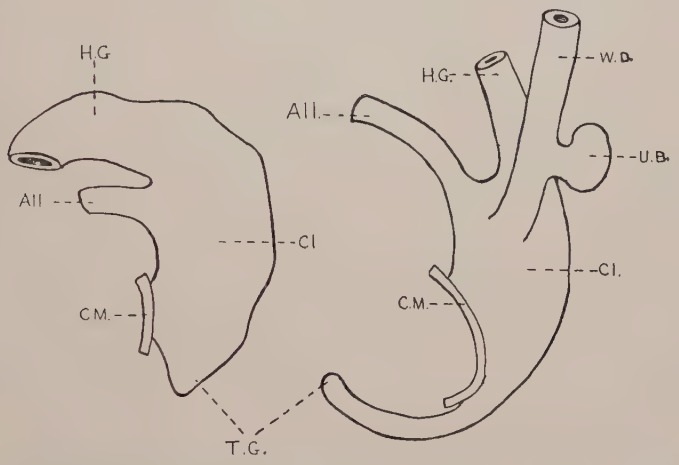

Fig. 539.—The cloacal region in embryos of 3.5 and 5.0 mm. respectively. *All.*, allantois; *Cl.*, cloaca; *C.M.*, cloacal membrane; *H.G.*, hind gut; *T.G.*, tail gut; *U.B.*, ureteral bud; *W.D.*, Wolffian duct. After Pohlman.[116]

Absence of the bladder is one of the rarest of anomalies of the urogenital system and but few case reports are to be found in the literature. Several cases from the older literature are cited by Meckel[114] and by Gould and Pyle.[100] Zuckerkandl[124] cites the more recent cases of Oliver and Pommer. In both of these cases the ureters terminated in the urethra. In the bladder region was found a small cavity the size of a bean which was regarded as the upper end of the urethra and into which the ureters emptied. The difficulty of differentiating between congenital absence of the bladder and acquired contracted bladder with inflammatory change has been pointed out by Zuckerkandl, for in the latter type of case the lumen of the bladder may be completely destroyed.

The case of Winter,[122] which has been cited elsewhere as typical of this condition, was found in a girl eight years old. The bladder and urethra were represented only by a shallow V-shaped depression on the lower abdominal wall. The lateral margins of the V were formed by small folds of skin continuous below with the labia majora. Labia minora were absent. At the apex of the V was located the vagina. The ureters terminated in the upper portion of the V-shaped depression. Un-

fortunately there is no description of the nature of this triangular area, but the accompanying figure, a colored lithograph, shows that it is markedly redder than the normal skin. Careful study of this case will show that the condition simulates exstrophy rather than congenital absence of the bladder. The rectum and anus are completely separated from the urogenital organs, indicating that the normal splitting of the cloaca had taken place, and the position of the ureteral orifices indicate the formation of the bladder. The case therefore appears to be one of exstrophy of the bladder with complete epispadias.

Double Bladder.—Before the significance of bladder diverticula was understood numerous cases of this condition were described as double or triple bladder. As a consequence the older literature concerning double bladder cannot be relied upon. Cruveilhier[91] in 1852 concluded that the bladder is always single, that the multiple bladders so frequently described by authors are merely herniæ through splits in the muscular membrane. Later studies, however, showed that all cases of so-called

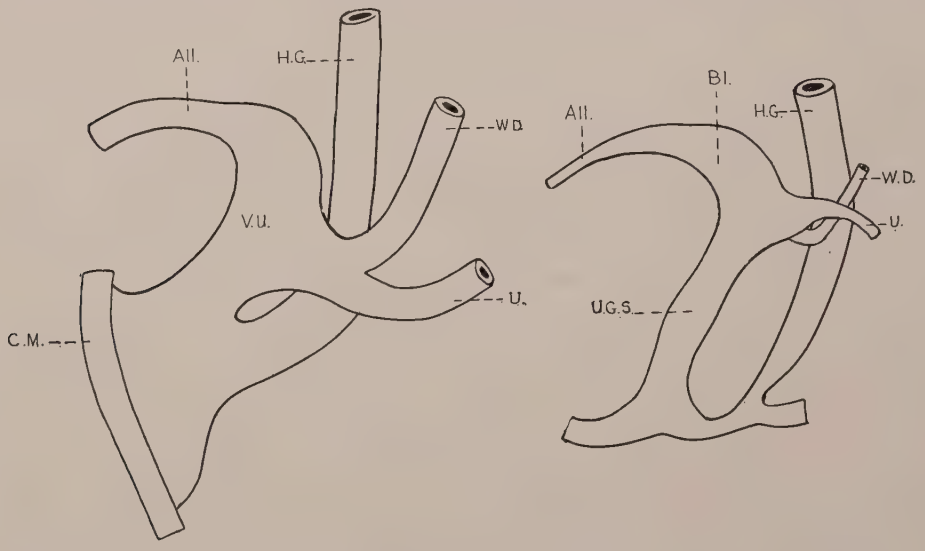

Fig. 540.—The division of the cloaca into the rectum and vesico-urethral anlage. Embryos of 12 and 16 mm. respectively. *All.*, allantois; *Bl.*, bladder; *C.M.*, cloacal membrane; *H.G.*, hind gut; *U.*, ureter; *V-U.*, vesico-urethral anlage; *W.D.*, Wolffian duct; *U.G.S.*, urogenital sinus. After Pohlman.[116]

double bladder could not be considered as diverticula, and an attempt was made to segregate the two types of cases. One of the earlier views expressed was that diverticula were without muscle coats, while double bladders possessed all the coats of the bladder. But numerous investigators found muscle fibers in cases of unquestionable diverticula and this brought about a division of the diverticula into the acquired, without a muscle layer, and the congenital, with the muscle layer.

Cathelin and Sempé[90] in 1903 made a careful study of double bladder and collected 32 cases from the literature. Of these, 17 were considered as *probable* cases, 15 as *certain*. They based their classification upon the following criteria:

1. In double bladder the ureters are found one in each of the two halves. Diverticula, on the contrary, never possess a ureteral orifice. This is considered a fundamental distinction between the two types of cases.

2. The orifice of communication between the two halves of the double bladder varies greatly in size; in diverticula it is usually small.

3. In double bladder a muscular coat is constant; in diverticula it is usually wanting.

4. In double bladder the bladder wall is usually otherwise normal; in diverticula it is never normal, but there is an hypertrophy of the muscular coat, of the trigone, etc. More recent investigations, however, have failed to substantiate all of these differences. Unquestionable diverticula have been described in which the ureter has been drawn into the cavity (Fischer,[97] Judd[106]), and congenital diverticula have been found in which there is no evidence of obstruction to the urinary outflow. However, the criteria as set forth by Cathelin and Sempé furnish an excellent working basis, and if used with discretion will serve to distinguish most cases of double bladder from diverticula.

Two types of double bladder have been described, one in which the dividing septum is placed in the sagittal plane, dividing the bladder into right and left halves, the other in which it lies in the frontal plane, forming anterior and posterior compartments. The former is the more frequent type and has been subdivided

FIG. 541.—Chonsky's case of vesica duplex. After Schwarz.[90]

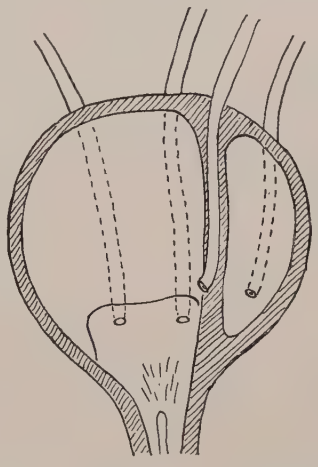

FIG. 542.—Vesica bipartita, showing four ureters. Juetting's case. After Schwarz.[80]

into *vesica duplex*, in which the two halves are entirely separated from one another except at the base, the other, *vesica bipartita*, in which the division is formed by an intravesical septum. A study of the cases collected by Cathelin and Sempé shows that those of Chonsky (Fig. 541), Schatz, Frank, and Cattirri are examples of vesica duplex; of Blasius, Testa, and Juetting (Fig. 542) of vesica bipartita. In the cases described by Chonsky and Cattirri the rectum lay between the two halves of the bladder; that of Schatz showed duplication of the whole genito-urinary system, two uteri, two vaginæ, and two bladders, a large one on the left and a smaller one on the right, each of which communicated with the halves of the vagina by a large opening. In vesica bipartita the septum may be incomplete anteriorly near the vesical orifice, as in the case of Blasius, or complete, as in the cases of Testa and Smith. The case of Smith showed, in addition, a double urethra and penis.

Of the cases in which the septum lies in the frontal plane, that of Cathelin and Sempé[90] is a good example. The anterior bladder was separated from the posterior by a thick septum which presented a rounded aperture of communication between

the two. The right ureter opened into the anterior bladder, the left into the posterior one. Schwarz[80] described a case of anterior and posterior bladders without communication between the two in a female. The anterior was drained by the normal urethra; the posterior by a "urethra" the meatus of which was situated just beneath the normal meatus. There was incontinence from the lower smaller "urethra." Injection of colored solutions into the two "bladders" showed no mixing of the solutions. The anterior bladder had a capacity of 140 c.c., the posterior of 80 c.c. The diagnosis of double bladder was made on these findings alone. One wonders if this were not a case of supernumerary ureter with an opening into the vestibule, and with a cystic dilatation at its lower end.

Concerning the embryology of double bladder nothing definite is known. As Cathelin and Sempè[90] assert, the fact that certain ganoid and teleost fishes are provided with bilocular and duplex bladders throws no light upon the subject as the bladders of fishes form as an expansion of the primary excretory ducts, and they do not, therefore, correspond to the bladders of amniotes. Undoubtedly the condition is the result of a splitting of the bladder anlage either before or after the urorectal septum has effected its division. In the majority of cases described the splitting affects only the bladder; in a few it affects both bladder and urethra. In these cases the splitting must have taken place after the urorectal septum had formed, affecting only the anterior division of the cloaca. Should the sagittal splitting take place before the normal division of the cloaca, we would expect two rectums as well. At least 2 cases of this kind have been described. The case of Gleiss[99] was of a female child, who showed two anal depressions, two anal furrows, double labia majora, vagina, urethra, and bladder. On incising the left anal furrow the gut was encountered at a depth of 3 cm. and showed a distinct and complete septum which divided the rectum into non-communicating right and left halves. In Lange's case[109] there was a double penis, double urethra, double bladder, each with one ureter, double scrotal raphé, double anal depressions, and atresia ani.

True double bladder is of such rare occurrence that its interest is academic rather than clinical. Nevertheless, diverticula, with which it has been so often confused, are so frequently encountered that the possibility of a double bladder should not be forgotten. The important points to be considered in the differential diagnosis are the degree of symmetry and position of the two cavities, the position of the ureteral orifices, the nature of the walls, the presence or absence of urinary obstruction, duplication of other closely related organs, etc. In most cases the diagnosis can be made without difficulty, in some the interpretation will remain doubtful.

Patent Urachus and Urachal Cysts.—The urachus is the remains of the allantoic stalk which in the embryo extends from the cloaca out into the umbilical cord. In the adult this structure is represented by a small solid connective-tissue cord which extends from the apex of the bladder to the umbilicus. Normally the lumen of the allantoic stalk becomes occluded early in fetal life. Many times, however, its cavity remains patent in whole or in part.

According to Vaughan[118] the varieties of patent urachus may be classified as follows: (1) Complete, the lumen being permeable throughout, (2) blind internal; the lumen being present only at the bladder end; (3) blind external, the lumen being present at the umbilical end; (4) blind, the lumen being patent only in the middle portion, and closed at both ends. In the complete form there is a direct

channel from the bladder to the umbilicus which allows the escape of urine. This form is the most frequently observed; perhaps, as Lower[113] suggests, it is impossible to overlook the condition. Undoubtedly numerous instances of the blind forms exist, but because they ordinarily give rise to no symptoms their presence is not detected. Occasionally, however, they give rise to cysts of varying sizes. In the blind external form infection plays an important rôle in their production; in the blind internal form the formation of the cyst in communication with the bladder is the result of obstruction to the urinary outflow. In the blind form the cause of the cyst is attributable to secretory activity of the lining epithelium.

No satisfactory data are available concerning the frequency of patent urachus and urachal cysts. Of the 12,500 admissions at the Brady Urological Institute the diagnosis of urachal cyst was made in only 3 cases, one of which was questionable. There were no cases of complete patent urachus, but this is probably accounted for by the fact that but few infants and children are seen in the clinic.

Vaughan[118] has collected 52 cases from the literature, of which 45 were completely patent, 4 were blind external, and 3 blind internal. Weiser[121] collected 86 cases of cysts of the urachus; of these the urachus was patent throughout in only 9, blind internal in 8, blind external in 7, and blind in 46.

Urachal cysts may be found at any point between the apex of the bladder and the umbilicus, but their usual location is at the lower third of this space. They vary in size from microscopic to one containing several liters of fluid. They lie behind the muscles of the abdominal wall, just anterior to the parietal peritoneum. As they expand they push the parietal peritoneum before them and bulge into the peritoneal cavity. They oftentimes suppurate and may rupture spontaneously. The usual point of rupture is at the umbilicus, but it may be below this or into the peritoneal cavity.

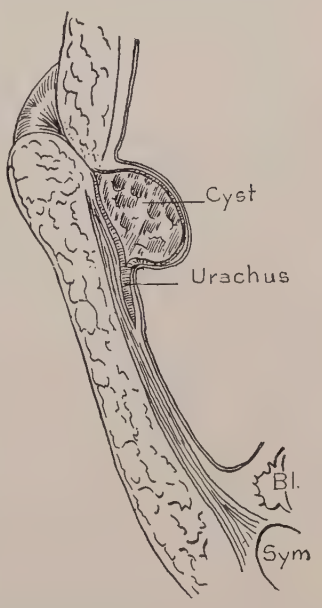

Fig. 543.—Cyst of the upper end of the urachus. After Davis.[93]

In patent urachus the characteristic finding is the escape of urine from the umbilicus. This may be only a few drops in amount or it may be sufficient to empty the bladder completely. The symptoms of urachal cyst vary greatly. Davis,[93] quoting from Wutz, states that the following symptoms may be found: mass between the umbilicus and the symphysis pubis, feeling of illness, loss of weight, abdominal pain, fever, gastro-intestinal disturbances, emaciation, and in 15 per cent. of all cases a discharging sinus at the umbilicus. Concerning its diagnosis Dössebber[94] in 1893 pointed out the possibility of confusion with other abdominal tumors, particularly those of the ovary. According to Cullen[92] the condition may be mistaken for distended bladder, ascites, appendicitis with abscess formation, ovarian cyst, localized peritonitis, and tuberculous peritonitis. A presumptive diagnosis may be made, therefore, by ruling out these conditions; a positive diagnosis is made in case of the blind cysts only at operation or at autopsy. In the case of urachal cysts in communication with the bladder (blind internal forms)

cystograms aid greatly in the diagnosis, but the distinction between this and a true diverticulum is not easily made unless the exact relations of the urachus are determined at operation.

Diverticula.—In reviewing the literature concerning diverticula one finds numerous synonyms mentioned, many of which are obsolete: double bladder, vesica bilocularis, vesica accessorius, vesica supernumeraria, cystocele interna, false bladder, Zellen, hernia tunicaire, sacs, pouches, cysts, etc.

The confusion which exists in the older literature between double bladder and diverticula has been mentioned above. Morgagni (cited by Fischer) is credited with first recognizing the difference between the two conditions. Cruveilhier[91] proposed the theory that diverticula were the result of a herniation of the bladder mucosa through the muscular coat and named the condition "hernia tunicaire." Outpocketings of the bladder possessing a muscular coat were considered to be double bladders; those without the muscle coat, diverticula. But as other observations were made, it became evident that this distinction would not hold, for diverticula were found which possessed muscle fibers. This then led to the subdivision of the diverticula into congenital, with the muscle coat, and acquired, without it, the "true" and "false" diverticula of Englisch.[95, 96] At the present day no attempt is made to distinguish between congenital and acquired diverticula upon histologic grounds, for the presence of muscle-fibers in varying numbers may be demonstrated in practically all diverticula (Young[123]). Cases in the young, coming on where no urinary obstruction is demonstrable, are considered congenital (Judd[106]); those coming on later in life and in which an obstruction to urination is present, are acquired. But even in the acquired diverticula a certain congenital weakness in the bladder wall must be assumed, since only a relatively small percentage of cases with urinary obstruction develop diverticula.

Diverticula are usually spherical in shape and their cavities communicate freely with that of the bladder by a sharply defined and constricted orifice. They vary in size from that of a small cellule to one larger than the bladder itself. Greene[101] reported a diverticulum which had a capacity of 1 gallon. The orifice is characterized by radiating folds of the bladder mucosa running toward it. About the orifice are muscle fibers which have to a greater or less extent a sphincteric action as has been described by Buerger.[88]

As a rule diverticula are found in three distinct localities in the bladder: (1) In the neighborhood of the ureteral orifices. According to Englisch[96] there is an absence of the muscle fibers of the longitudinal layer at this point, the circular and oblique layers alone forming the muscularis. On this account this region offers the point of least resistance, so that the majority of diverticula are formed at this point. The ureteral orifice is but seldom carried into the diverticulum, due, no doubt, to the fixation of the trigone. (2) Second in importance as a point of predilection for the formation of diverticula is in the region of the apex of the bladder. Some of these diverticula Englisch explains as due to a patent urachus, and they are not, therefore, diverticula in the true sense of the word. Others are due to a weakness in the longitudinal muscle coat in the region of the urachus. (3) The posterior bladder wall behind the interureteric ridge. Diverticula in this region are usually found in cases of benign prostatic hypertrophy.

The causes of diverticula have been divided into (1) intra-uterine, (2) obstacles to urination, (3) traumatic. The intra-uterine causes are responsible for the truly

congenital diverticula. Englisch[96] has observed that the urethra of the fetus sometimes becomes temporarily occluded through the agglutination of the lining epithelium. Owing to the retention of urine a diverticulum is formed and remains after the urethra once more becomes patent. Pagenstecher[115] advanced the view that congenital diverticula result from an anomalous embryonal development, due

FIG. 544.—Complete ectopia vesicæ. B. U. I. 6388.

to a superabundance of tissue. A somewhat different view is expressed by Joly,[105] who believed that "supernumerary ureteric buds" which did not reach the kidney, later expanded to form diverticula. These two latter views, however, have received no embryological confirmation.

The acquired types do not concern us directly in a consideration of congenital malformations, except that they are due to a probable congenital weakness in the

muscle coat. They are found in bladders where there is a definite obstruction to urination from benign prostatic hypertrophy, tumor, etc.

Of 12,500 admissions to the Brady Urological Institute a diagnosis of bladder diverticula was made in 259 cases. Fischer[97] and Lerche[111] have collected small series of cases of this condition. The age incidence as given by Fischer shows that the majority of cases of congenital diverticula are found between the ages of thirty and seventy years, but cases have been reported in early childhood and even in the fetus. The condition is more frequent in males than in females in the ratio of about 10 to 1.

Fig. 545.—Exstrophy of bladder with epispadias and ulcerative cystitis. Note ureteral orifices, verumontanum, broad spade-like penis. B. U. I. 6388.

Bladder diverticula may exist without giving rise to symptoms, many cases being found accidentally at operation or autopsy. The patient may, after urination, feel that the bladder is not completely emptied, and be able, after a short interval, to repeat the act. It is usually through infection of the diverticulum that symptoms become manifest. Because of the poor drainage afforded by the orifice of the diverticulum pus may collect in the cavity and a condition analogous to a poorly draining abscess result. In such cases the patient may at intervals urinate large quantities of foul-smelling pus. The stagnant condition of the urine within the diverticula favors highly the formation of calculi, and not infrequently stones are found in them. With these complications painful and frequent urina-

tion with occasional hematuria, pain in and about the bladder, sensation of pressure and fulness in the lower abdomen, in addition to general systemic disturbances, are the usual symptoms.

The diagnosis of diverticula of the bladder may be easily made by a cystoscopic examination; their presence should be sought in every case with urinary obstruction. Cystograms taken at various angles are now used extensively not only as an aid in diagnosis, but to determine the size, shape, and position of the diverticula.

Exstrophy.—Ectopia vesicæ, or exstrophy of the bladder, is that condition in which the anterior wall of the bladder and a corresponding portion of the lower anterior abdominal wall are completely lacking. The posterior bladder wall,

Fig. 546.—Case of exstrophy of bladder in female of thirteen years. Complete absence of urethra.

including the trigone, is pushed forward through the defect in the body wall, and lies on a level with, or slightly above, the general abdominal surface. As viewed from in front one sees usually a rounded defect in the integument in the suprapubic region through which protrudes the reddened and inflamed mucosa of the bladder. The ureteral orifices may be visible, and may be seen to spurt small jets of urine, which in the absence of the bladder keeps the surrounding parts constantly wet and inflamed. The condition is agreed by all to be one of the most distressing of the congenital anomalies, for it is one which tends toward further aggravation and complications, and one in which repeated surgical attempts to correct the condition often result in little or no betterment.

Cases of exstrophy of the bladder have been classified according to the degree

of the malformation into complete and incomplete types. In the latter there is a defect of either the upper or lower portion of the anterior bladder wall. In these cases the symphysis pubis is united and the urethra is complete. The complete type is the more common, and is characterized by the absence of a symphysis pubis and by epispadias. The pubic bones are widely separated, sometimes as much as 10 to 12 cm., and the intervening space is filled with connective tissue. The posterior bladder wall is pushed through the rounded defect in the abdominal wall by the intra-abdominal pressure, and presents a convex surface, which appears as a rounded salient tumor. The mucosa is thrown into folds such as are seen in the contracted bladder. At the circumference of this tumor the transition between bladder mucosa and skin is sharp and marked by a white, retracted, cicatricial band. The ureteral orifices are situated usually in the lower half of the bladder area, but may be hidden in the depths of the mucosal folds.

The penis is small, flattened dorsoventrally, and epispadiac; the prepuce a loosely attached tag of skin. The scrotum is small, but otherwise normal; cryptorchidism is often associated with the condition. The urethra is incomplete, its whole anterior wall being absent. It presents, therefore, as an open sulcus of slight depth, which extends from the bladder mucosa to the glans penis. At the bottom of the urethral sulcus the verumontanum and ejaculatory ducts are often observable. The prostate and seminal vesicles are either entirely lacking or atrophic. In the female epispadias is likewise present. The urethra is again a shallow open sulcus and the labia minora widely separated superiorly. The clitoris is divided, its halves being situated at the upper ends of the labia minora.

The umbilicus is situated lower on the abdominal wall than normally. Sometimes it appears to be absent, due to the fact that it is hidden in the scar tissue at the superior border of the exstrophied bladder mucosa. The urachus is often lacking; when present it has the form of a crescent with its concavity facing inferiorly.

Other congenital anomalies are frequently associated with exstrophy of the bladder. Perhaps the most interesting of these is one in which the intestine opens directly on the exstrophied parts. The rectum is absent, although an anal depression is ordinarily present. Keith[108] has collected 14 cases of this type, all of which showed spina bifida in addition. To these von Geldern[120] has added 8 cases which he collected from the literature and 1 of his own observation. Other coexisting anomalies are spina bifida, prolapsus recti, uterus bicornis, harelip, inguinal hernia, cryptorchidism, etc.

The manner in which exstrophy of the bladder is brought about is not definitely known, but numerous theories have been proposed to explain its etiology. These theories fall into three main groups: (1) That it is the result of a mechanical rupture of the bladder; (2) that it is due to a pathologic lesion; (3) that it results from defective embryonic development.

The first theory, credited to Bon and Duncan (1805),[87] and maintained by Mueller, Rokitansky, Winckel, Brandl, Tiersch, and others, holds that during embryonic life the urethra becomes occluded and the bladder fills and ruptures through the thin abdominal wall. The picture of exstrophy is completed by the formation of adhesions between the ruptured edges of the bladder wall and the anterior abdominal wall. This view, however, does not explain the concurrent epispadias and non-united pubes; moreover, it has been pointed out that normally

the pubes unite before the kidneys begin to function. The view no longer has any noteworthy adherents.

According to the second view exstrophy is brought about by an ulceration of the dorsal surface of the penis and of the lower anterior abdominal wall (Velpeau) or by the formation of adhesions between the embryonic membranes and the abdominal wall. These adhesions are supposed to produce a fissure through which the bladder protrudes and to prevent the union of the pubes (de Quatrefages). Such theories, however, fail to explain the constant anatomical relations found in the malformation as well as the complete absence of the scars of any definite pathologic lesion. The theory, therefore, has fallen into the discard.

The view that exstrophy is due purely to an embryologic defect has been maintained by Geoffrey St. Hilaire, Meckel, Jaimain, Voillemier and Le Dentu, Keibel, Gilis, Vialleton, and others. The older views were mostly hypothetical and were not based upon sound embryologic knowledge. Foremost among these was the view of Jaimain, who believed that exstrophy resulted from the failure

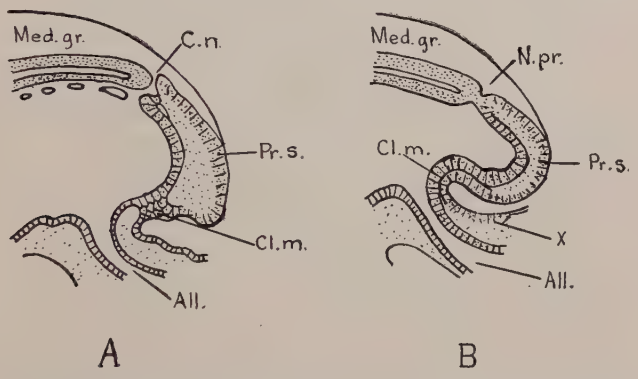

FIG. 547.—Median sagittal sections through the primitive streak region. A, Eternod's embryo (8 pairs of somites). The cloacal membrane developing in the usual manner at the caudal end of the primitive streak. B, Kroemer-Pfannenstiel embryo. The primitive streak extends beyond the cloacal membrane and upon the body stalk. *All.*, allantois; *Cl.m.*, cloacal membrane; *C.n.*, neurenteric canal; *Med.gr.*, medullary groove; *N.pr.*, primitive knot; *Pr.s.*, primitive streak; *x*, extension of the primitive streak beyond the cloacal membrane. After Lewis.[112]

of the lateral halves of the abdominal wall and bladder to unite in the midline. This view is adopted by Kelly and Burnam,[26] who attribute the malformation to "a failure of the tissues of the embryo, which go to form the abdominal walls, to meet in the median line, a defect in the prevertebral laminæ analogous to harelip, cleft palate, congenital omphalocele, and spina bifida." This view, however, is not tenable, for were the defect primarily one of the abdominal wall, we would expect it to involve a greater area than that limited to the bladder, and to find the peritoneal cavity communicating with the outside. The condition cannot be analogous with spina bifida, harelip, and cleft palate, for in these conditions we have to deal with groove-like structures which form closed cavities by the union of ridge-like processes. Exstrophy does not form in this manner, for the entodermal cavity is a closed one from the time of its formation (yolk sac), and remains so until the bladder and urethra are formed.

The most tenable theories are those of Keibel, Gilis, and Vialleton. The theory of Keibel[107] is based upon his own careful studies of the tail region of human embryos. He has shown that the cloacal membrane develops from the caudal portion of the

primitive streak region of the embryo (Fig. 547, A). In certain cases, as in the Kroemer-Pfannenstiel embryo (Fig. 547, B) the primitive streak extends beyond the cloacal membrane and upon the body stalk. It covers, therefore, the area which later gives rise to the genital papilla and the lower abdominal wall. Since the primitive streak of mammals is regarded as the equivalent of the blastopore of lower vertebrates, Keibel believes that exstrophy of the bladder is the result of a persistent open blastopore.

According to Gilis[98] exstrophy is likewise due to an opening up of an orally extended cloacal membrane, but the opening does not have the phylogenetic significance that is given to it by Keibel. Normally the infra-umbilical region of the abdominal wall is strengthened by the median growth of the protovertebral laminæ of mesoderm, which give rise to the abdominal muscles and fasciæ. If these

Fig. 548.—Case of exstrophy of bladder. *x*-Ray showing wide separation of symphysis pubis. B. U. I. *x*-Ray 4671.

muscles are arrested in their development, and do not reinforce the cloacal membrane, the latter breaks down and exstrophy results.

Vialleton's theory,[119] which is accepted as the most plausible by Legueu and Michon,[110] is based upon a division of the infra-umbilical region into two portions, a posterior, which is the cloacal membrane, and an anterior, which is that portion of the primordial body wall lying between the cloacal membrane posteriorly and the arc of the umbilicus anteriorly. He assumes an arrest of development of the anterior portion of the body wall and believes that the cloacal membrane extends forward to cover this portion. The cloaca undergoes the same extension, and as it splits throughout its whole extent, the anterior wall will present a defect from the umbilicus to the root of the tail. If the posterior part of the cloacal membrane develops normally, the tissues of the perineum and anus will be normally formed. But in front of the perineum, under the umbilicus, will persist a fissure due to the

exceptional and abnormal hyperplasia of the cloacal membrane; the result will be exstrophy. The protovertebral mesoderm will not be able to grow into the hiatus and the recti muscles and pubes will remain separated. The same deficiency brings about a cleft in the umbilical surface of the genital papilla when this structure forms, and epispadias results. Epispadias and exstrophy are then intimately related to one another, and the above theory is sufficient to explain all the intermediary anomalies between the simplest epispadias and the most complete exstrophy.

The recent case of exstrophy of the bladder described by von Geldern[120] throws much light upon the etiology of those cases complicated by the presence of opening of the intestine at the site of the exstrophy. The case was found in a newborn child which showed the following malformations: bladder exstrophy, rudimentary penis with epispadias, but without glans or prepuce, bifid scrotum, undescended testicles, spina bifida, and absent anus. The exstrophied parts presented two lateral and one central masses (Fig. 549). The small intestine was found to open

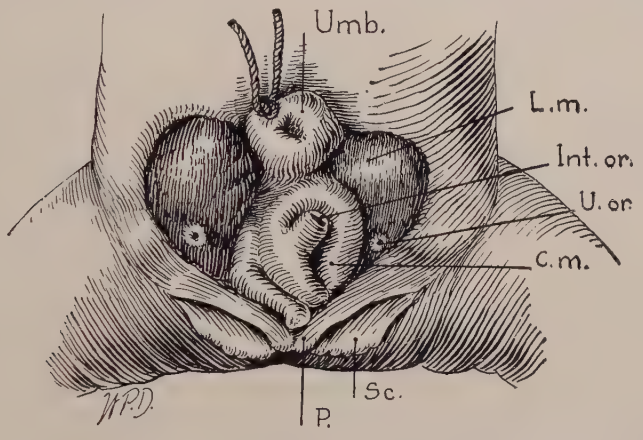

Fig. 549.—A case of exstrophy of the bladder complicated by intestinal openings on the exstrophied area. *C.m.*, central mass; *Int.or.*, intestinal opening; *L.m.*, lateral mass; *P.*, divided penis; *Sc.*, scrotum; *Umb.*, umbilicus; *U.or*, ureteric orifice. After von Geldern.[120]

to the outside through the central mass. On either side of this opening were two other openings which led into blind spindle-like diverticula (Fig. 550). These are regarded by the author as a modified caudal intestine (tail gut). Above the latter openings were the orifices of the ureters. Dissection of the parts showed that each ureter joined with the vas deferens of its own side at a point about 1.5 cm. from the orifice. The common duct of the ureter and vas, therefore, represented a persistent terminal portion of the Wolffian duct. Microscopic studies of the various parts showed that the central exstrophic mass was covered with mucosa characteristic of the large intestine, while that of the lateral masses was typically that of the bladder. The rudimentary penis showed widely separated corpora cavernosa, while the corpus spongiosum was situated dorsal to and between them. A rudimentary prostate was found, which presented a large cyst.

The etiology of the condition is discussed by von Geldern. Briefly he accepts the theory of Johnston,[104] believing that the condition is brought about by an early rupture of the cloacal membrane with an arrest in the development of the urorectal septum. He suggests a disturbed chemical balance as the underlying factor in the

production of the anomaly, basing his hypothesis upon the experimental production of spina bifida by Morgan and Hertwig. He states: "It seems likely that a chemical substance, if such is present, has in these complicated cases of exstrophy of the bladder (ectopia cloacæ) caused not only an arrest in the middorsal region of the body, but also an arrest in the midventral region of the body. It further seems likely that the arrest has affected those parts which had not completed their embryonal development, and that when development recommenced, certain primitive embryonal structures were maintained and developed as such, and those which should have undergone differentiation, had no arrest occurred, failed to make these changes."

Of the various theories proposed those of Keibel and Gilis appear to be the most satisfactory. In order to produce a cleft extending from the genital papilla to the umbilicus it is necessary to assume a forward displacement or extension of the cloacal membrane. Keibel has shown that this actually occurs in the form

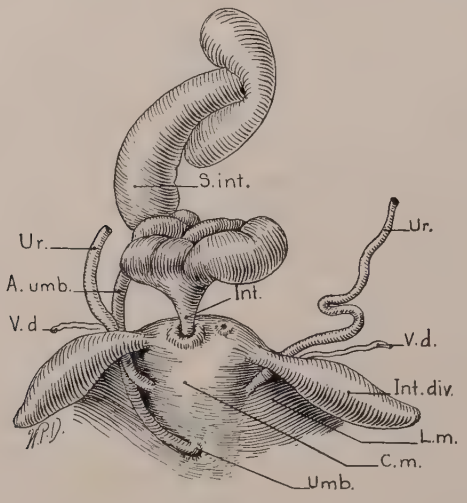

Fig. 550.—The same case shown in Fig. 549 viewed from behind after dissection of the parts. *A.umb.*, umbilical artery; *C.m.*, central mass; *Int.div.*, intestinal diverticulum; *Int.*, intestinal orifice; *S.int.*, small intestine; *Umb.*, umbilicus; *Ur.*, ureter; *V.d.*, vas deferens.

of the primitive streak in the case of the Kroemer-Pfannenstiel embryo, Whether or not the cleft formed represents an open blastopore (Keibel), or a simple breaking down of the cloacal membrane, is a point of little consequence. The view of Vialleton assumes as a cause for the anterior extension of the cloacal membrane a primary defect in the anterior body wall. It is, however, difficult to conceive of any defect in this structure which could be so easily supplemented by the cloacal membrane. The defect in the abdominal wall would appear to be effect rather than cause. The attempt of von Geldern to go back a step further and give to the anomaly a chemical basis as the underlying cause is laudable. Although a few anomalies have been produced experimentally by changes in the physicochemistry of the developing ova, we are yet far from an understanding of these phenomena.

Fortunately, exstrophy of the bladder is a rare anomaly. Various statistics naturally show wide variations. Spooner,[117] combining the statistics of Henow, Sickel, and Winckel, obtained 4 cases in 116,500, or about 1 in 30,000. Neudoerfer places its frequency at 1 in 50,000, probably a more accurate figure. It is more

frequent in males than in females in the ratio of about 8 to 1. Of the 12,500 admissions to the Brady Urological Institute there were 6 cases of bladder exstrophy, of which 5 were males and 1 female.

The symptoms of exstrophy of the bladder are characteristic. The gait is described as waddling, the result of the wide-spread, ununited pubes. There is a strong offensive, urinous odor to the patient. The protruding vesical mucosa is red, inflamed, and very sensitive. The parts are constantly bathed with infected urine, the clothes become soaked, and their rubbing on the bladder mucosa and surrounding skin causes excoriation. Because of the exposed position of the ureteral orifices, ascending infection of the kidneys frequently complicates the condition and results in pyelitis, pyelonephritis, and pyonephrosis, with the usual concomitant symptoms of these conditions, often terminating in uremia and death. Because of the liability to renal complications few patients reach old age; Buerger[88] records that of 74 children born with exstrophy only 23 passed the twentieth year of life. A rare complication of exstrophy is that of malignant change in the bladder mucosa. Cases of this nature have been reported by Bergenhein[86] and Hunner.[102]

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E. URETHRA

Development of the Urethra.—The early stages have been traced in connection with the development of the bladder. It has been shown how the cloaca is split in the frontal plane by the urorectal septum into the rectum dorsally and the vesico-urethral anlage and the urogenital sinus ventrally. In both sexes the division between the latter two structures is a more or less arbitrary one and is located at

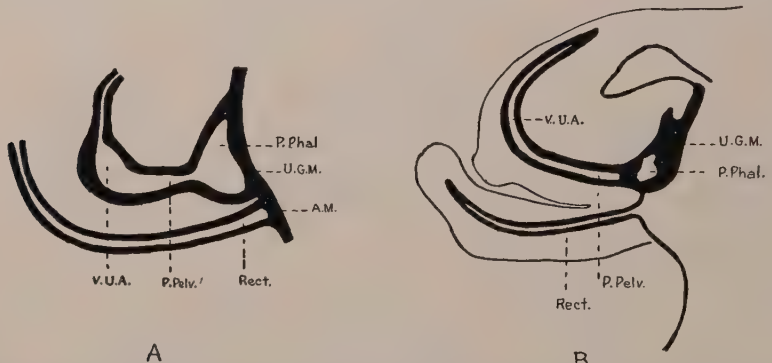
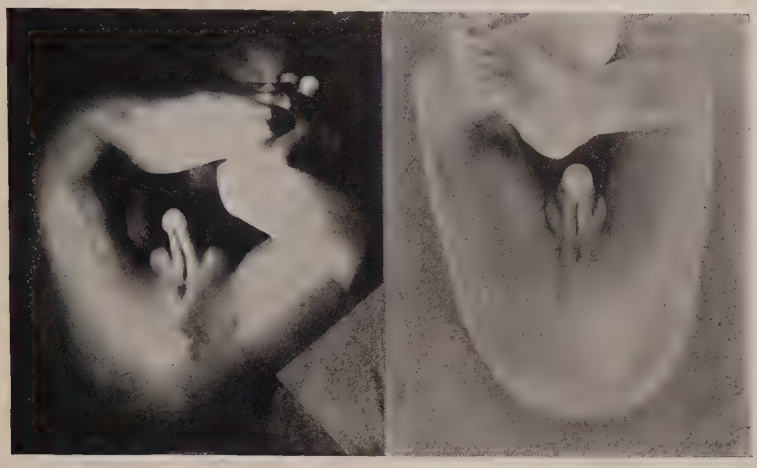


Fig. 551.—Two stages showing the early development of the urethra: A, Embryo of 11 mm., B, embryo of 24 mm. *A.M.*, anal membrane; *P.Phal.*, pars phallica urogenitalis; *P.pelv.*, pars pelvina urogenitalis; *Rect.*, rectum; *U.G.M.*, urogenital membrane; *V.U.A.*, vesico-urethral anlage. After Felix.[114]

the point at which the urogenital ducts (Wolffian and Müllerian) join the ventral half of the cloaca. The upper portion of the vesico-urethral anlage expands to form the bladder; the lower half remains narrow and forms what is termed the "true urethra." The urogenital sinus begins at the orifices of the Wolffian and Müllerian ducts and extends to the urogenital membrane (ventral portion of the divided cloacal membrane). As is well known this structure becomes the lower portion of the adult male urethra; in the female it forms no portion of the urethra whatsoever, but is converted into the shallow but broadened vestibule (Johnson[144]).

With the growth of the cloacal tubercle the urogenital sinus elongates, the elon-

gation being much more extensive in the male than in the female. For descriptive purposes Felix[14] has divided the urogenital sinus into two parts, "pars pelvina," which remains within the pelvis, and a "pars phallica," which grows outward with



A B

FIG. 552.—A, External genitalia of male embryo of 37 mm. B, Same of female embryo of 40 mm. The figures show the relative extent of the urogenital groove in the male and female at an early stage. After Spaulding.[165]

the growth of the cloacal tubercle (Fig. 551). The pars phallica is limited anteriorly by the urogenital membrane. When this breaks down, which it does by means of resorption in embryos of 12 mm. or less (Spaulding[165]), the pars phallica be-

A B

FIG. 553.—A, External genitalia of a male embryo of 58.8 mm. B, Same of a female embryo of 65 mm. The urogenital groove in the male is seen to be closing from behind forward to form the urethral canal and raphé. The primitive urogenital opening in the male no longer extends on the glans. The tip of the glans is crowned by a meaningless epithelial horn. After Spaulding.[165]

comes open to the outside along its ventral wall, thus forming the "urogenital opening."

Herzog,[141] Felix,[14] and Spaulding[165] speak of this opening as the "primitive" urogenital opening, in contradistinction to the "definitive" opening which is formed

later. According to Herzog the primitive urogenital opening extends only as far as the coronal sulcus; it does not extend on the glans at all. Spaulding, however, states, "In the male it (urogenital opening) consists of a long slit extending from the base to the apex of the phallus, whereas in the female it extends only to the

A B

Fig. 554.—A, External genitalia of a male embryo of 83.2 mm. B, Same of a female embryo of 78 mm. After Spaulding.[165]

base of the glans" (Fig. 552). Spaulding shows, however, that this condition exists only in embryos up to 45 mm.; he considers this relationship to be of prime importance in the differentiation of sex from the external genitalia up to this stage. In older embryos as the glans grows forward the urogenital opening lags behind,

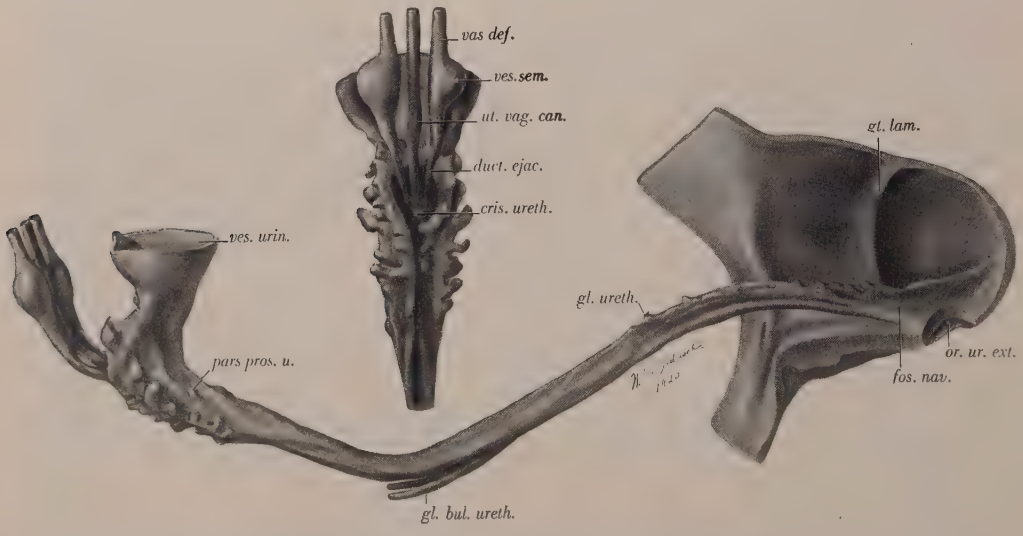


Fig. 555.—Lateral view of a wax reconstruction of the urethral epithelium of a human embryo of 65 mm. The insert is a posterior view of the prostatic urethra. After Johnson.[144]

and in embryos of 60 to 80 mm. it "is shifted to a more terminal position in the frenular notch of the glans" (Figs. 553, 554).

Normally the urogenital membrane closes by a coalescence of the lips of the urethral gutter or groove and the raphé is formed. This closure, according to

Spaulding, begins at the base and proceeds forward, gradually converting the whole of the elongated groove-like urogenital opening into a closed tube. Herzog has shown that the urethral plate, the terminal remains of the urogenital membrane, splits in the midsagittal plane and is converted into a deep groove. This groove, which forms a forward extension of the primitive urogenital opening, is then gradually closed again from behind forward, to form a tube in a similar manner to that by which the remainder of the urethra was formed. It remains open only at the apex of the glans where it forms the definitive urethral opening. Regarding the urethral opening Spaulding states: "It (the primitive urogenital opening) then becomes entirely closed and eventually there is formed the new, permanent terminal urethral opening on the apex of the glans." The impression is given that at some stage the urogenital tube of the male is completely closed terminally. Johnson's observations do not confirm this; in stages of 65, 75, 88, 90, 100, 130, and 147 mm. in length external urethral orifices were observed in all. In an

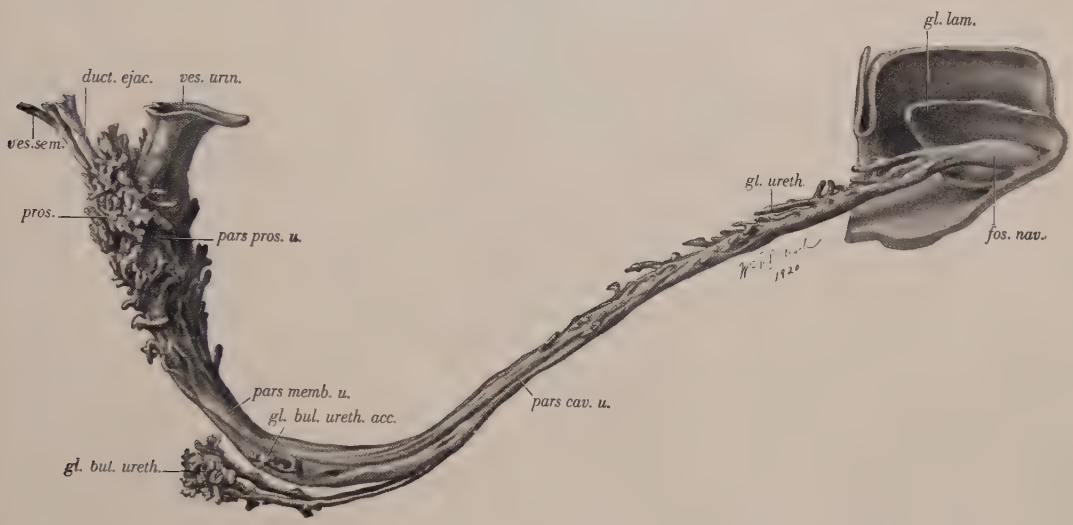


FIG. 556.—Lateral view of a wax reconstruction of the urethra of an embryo of 130 mm. After Johnson.[144]

embryo of 55 mm. the orifice is placed on the ventral surface of the shaft, corresponding with the previously described primitive urogenital opening. At 65 mm. it lies at the coronal sulcus (Fig. 555). At 78 mm. the orifice lies in the expanded ventral half of the urethral plate. In still older stages it becomes gradually shifted toward the apex of the glans. When the urethral plate is completely split and reunited along its ventral edge, the terminal portion of the urethra appears as a slit-like cavity in the median plane, the fossa navicularis. These details are emphasized because of their important bearing upon a correct interpretation of hypospadias.

In the female the urogenital opening remains as a cleft beneath and along the ventral surface of the cloacal tubercle. Its walls do not fuse as in the male; it remains open to form the orifice of the vestibule.

The further development of the urethra in the male consists in its continued elongation and in the development of its glands. The first of these to form are Cowper's glands which have been reported by Eggerth[132] to be present in an embryo

of 30 mm. At 65 mm., as shown in Fig. 555, they are represented by solid, cylindric epithelial sprouts which are directed bladderward, paralleling the urethra. With continued growth the ducts acquire lumens and branch terminally; finally their epithelium is converted into one of the mucus-secreting type.

In the female Bartholin's glands, the homologue of Cowper's glands, develop in a similar manner from the ventral wall of the urogenital sinus (Fig. 558). Their ducts branch, but never become elongated as in the male.

Fig. 557.—Posterior view of model shown in Fig. 556.

The prostate takes its origin from the prostatic urethra as knob-like epithelial sprouts. These are located on the ventral, dorsal, and lateral walls of the urethra, both above and below the openings of the genital ducts (Figs. 555, 556). Their presence has been noted in an embryo of 55 mm. (Johnson[144]), Lowsley[156] reporting their absence at 50 mm. As the glands increase in number, and grow in length, they undergo branching, and in the older stages form a mass of glands completely surrounding the urethra. The further development of the prostate consists in

the further growth and branching of its glands, in the transformation of its epithelium into a secreting one, and in the differentiation of the surrounding mesenchyme into connective tissue and muscular elements.

In the female prostatic tubules develop in a similar manner to those in the male (Figs. 558, 559). They do not, however, form in so great numbers or reach as high a development. In the adult they are found along the urethra and about the urethral orifice in the vestibule. They form the urethral and para-urethral (Skene's) glands of the female, which are, therefore, to be considered the homologue of the prostate in the male (Johnson[144]).

The small urethral glands of the male (glands of Littré) likewise make their appearance in embryos of 50 to 55 mm. in length. At first they are few in number and confined to the pubic surface of the distal portion of the cavernous urethra. A little later they appear on the rectal and lateral walls. For the most part they are directed bladderward, as are the ducts of the prostate and Cowper's glands. They are distributed along the anterior two-thirds of the cavernous urethra, and are

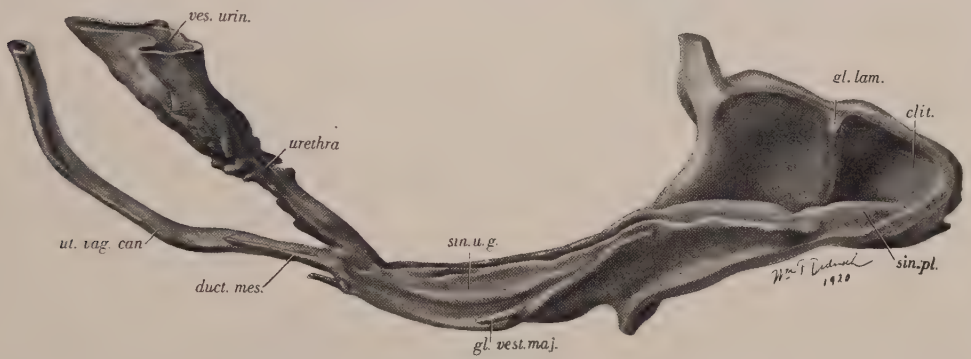


Fig. 558.—Lateral view of a wax reconstruction of the urethra and associated epithelial structures of a female embryo of 60 mm. The right half of the clitoris has been dissected away, showing a concavity filled with mesenchymal tissues. The urogenital sinus is much shorter, but broader than in the corresponding stage of the male. Its only glands are the major vestibular or Bartholin's glands, the homologues of Cowper's. At the junction of the uterovaginal canal and urethra is seen the distal remnant of the Wolffian duct (*duct. mes.*). The urethra shows numerous glands which are true homologues of the prostatic gland. A few of these glands are also found at the junction of the urethra and uterovaginal canal. After Johnson.[144]

not found as far back as the orifices of Cowper's glands. They are most numerous on the pubic surface of the urethra where they first appear. Their ducts open into the lumen of the urethra in the fissures between adjacent mucosal folds. As these folds run longitudinally, the glands appear in rows, of which may be recognized a midpubic and midrectal row, and paired lateral and lateropubic rows. They finally develop into branched tubulo-alveolar glands.

In the female glands similar to the glands of Littré develop. They are fewer in number, smaller, and less important than those of the male. They are confined to the anterior portion of the urogenital sinus (Fig. 559). In the adult they are known as the minor vestibular glands.

While the urethra is at first a simple tubular structure, in the later stages its mucosa is thrown into a number of longitudinal folds. The first of these to form is situated on the rectal wall of the upper portion of the pars pelvina. It is known as Müller's hillock and becomes the crista urethralis (colliculus, verumontanum) of the adult. Through its mesenchyme pass the paired Wolffian ducts and the

uterovaginal canal to open into the urethral lumen on its summit. This is the largest, most constant, and most important of the folds to form. Other mucosal folds make their appearance in later stages both above and below the verumontanum. In the membranous and cavernous urethræ they are especially prominent. They are, however, more variable and more irregular than the crista urethralis. Nevertheless they remain throughout life, but, unlike the crista, they disappear when the urethra is distended.

Absence of the urethra in cases where the penis is present is a rare anomaly and only a few cases are recorded in the literature. Kaufmann was able to collect 7 cases in which he believed there was complete absence, implying a failure to develop of the urethral anlage, at least the pars phallica of the urogenital sinus.

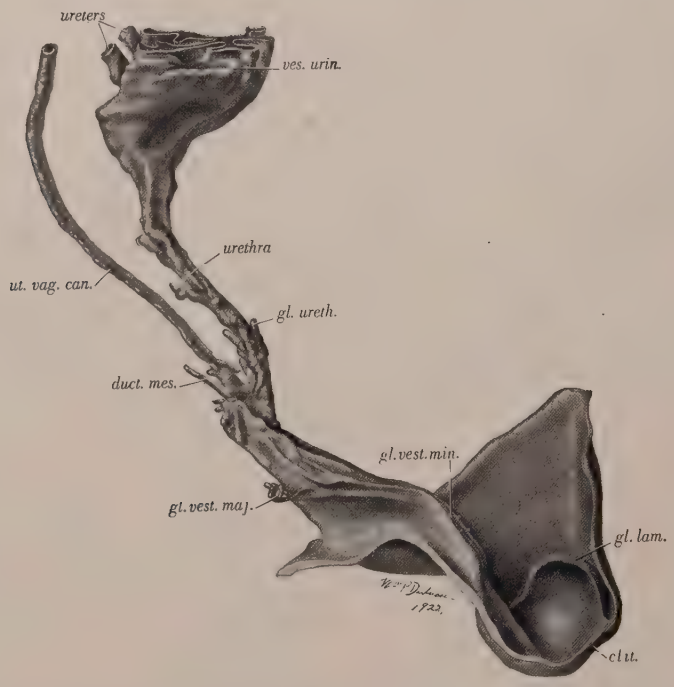


Fig. 559.—Lateral view of a wax reconstruction of the urethra and associated epithelial structures of a female embryo of 75 mm. The urethral glands have increased in size, but are still unbranched. Bartholin's glands, however, now show several branches. In addition, the urogenital sinus shows on its dorsal surface five small epithelial buds, the beginnings of the minor vestibular glands. These glands are represented in the male by the glands of Littré. The glandar lamella is again prominent and is seen to be shifting its position in a similar manner to that of the male. After Johnson.[144]

Mention may be made here of that congenital anomaly in which the urethra, once formed, becomes totally obliterated and reduced to a solid cord. According to Kaufmann,[146] Depaul has collected 3 cases of this type, only one of which, however, was proved with certainty at autopsy.

Cases with complete urethral obstruction of these types seldom result in the death of the fetus (only 1 case of 8 reported being stillborn). In 2 there was a patent urachus, in 2 others the bladder had ruptured into the rectum, while 4 were treated by operation and lived.

Accessory Urethral Canals (Double Urethra).—Under the term of "double urethra" have been described a number of urethral malformations in which the

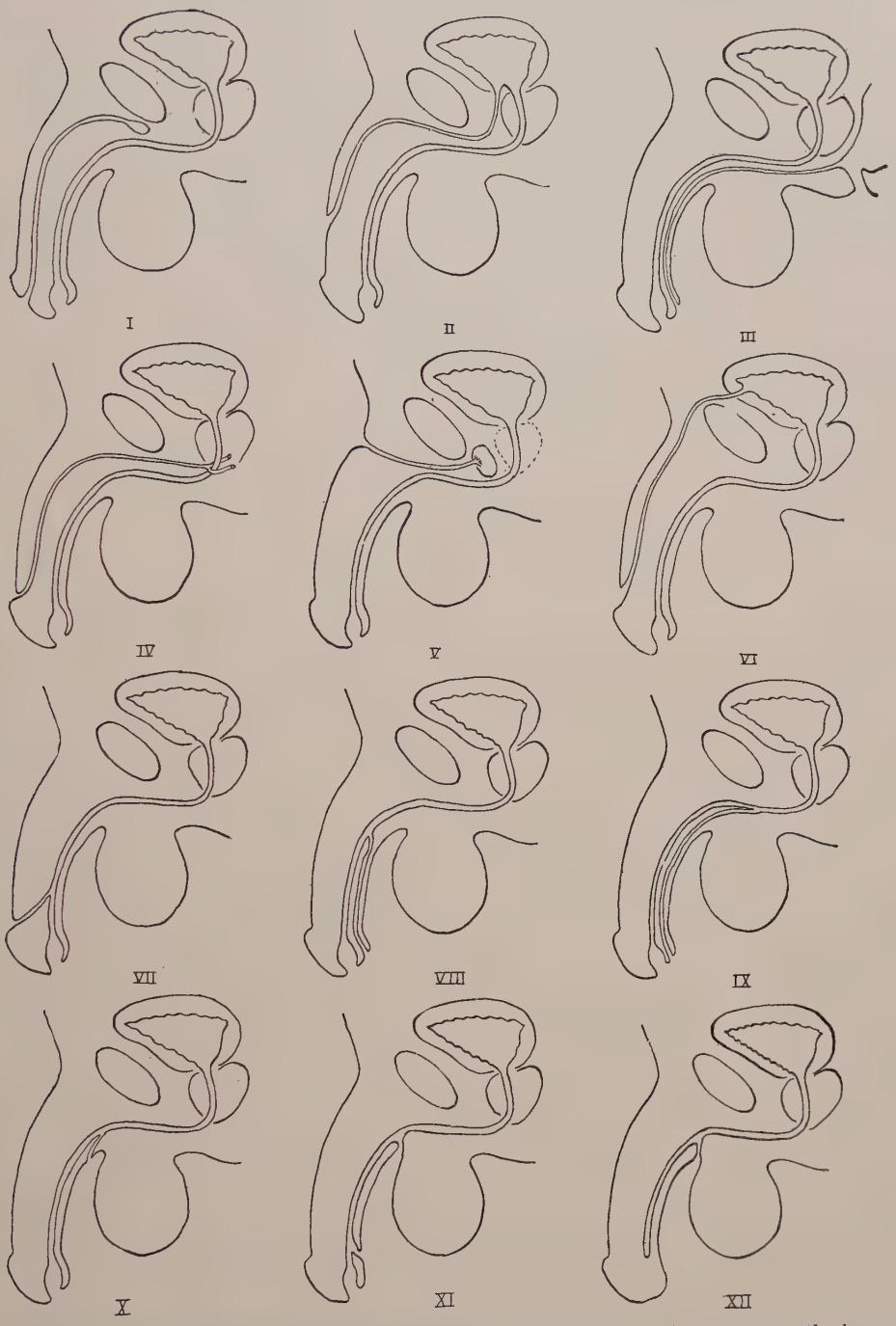


Fig. 560.—Semi-diagrammatic representation of the various types of accessory urethral canals. The drawings have been copied from the originals or made from the author's descriptions: I, Most common type, 31 cases collected by MacKenzie; II, complete duplicity of the urethra. Lebrun, et al, 7 cases; III, Monod's case; IV, Cruveilhier; V, Luschka; VI, Lissowsky; VII, Dollinger; VIII, Meisels, Woods, Poisson; IX, Marion; X, Reitz; XI, Lippert; XII, LaCroix.

urethra is found wholly or partially duplicated. Various other terms which have been applied to the same condition are: accessory urethral canals, fistulæ juxta-

urethrales, congenital diverticula of the urethra, epispadiac urethra, paraurethral ducts, etc. Collections of cases have been made by von Fault,[139] MacKenzie,[159] and Oudard and Jean.[161] The latter authors give preference to the term "accessory urethral canals," and this term will be used in the following account. A distinction shall be made between these accessory urethral canals, which are long channels paralleling the urethra on either its dorsal or ventral surface, and those shorter and smaller ducts (paraurethral ducts) found about the external meatus or on the surface of the glans. The following classification of the accessory urethral canals has been furnished by Oudard and Jean[161]:

1. Accessory urethral canals opening above the normal meatus and extending as far backward as the suspensory ligament or space of Retzius and ending blindly.
2. Rudimentary accessory canals shorter than the former and lying either laterally to, above, or below the normal urethra.
3. Accessory canals extending into the bladder (true double urethra).
4. Duplicity of the urethra with duplicity of the penis.

In the following account a more simplified classification has been used:

1. True duplication of the urethra and penis.
2. Accessory canals situated dorsal to the normal urethra.
3. Accessory canals situated ventral to the normal urethra.

Duplication of the Urethra and Penis.—True duplication of the urethra with duplication of the penis is a rare anomaly and but few cases have been recorded in the literature. Kaufmann[146] collected 3 cases from the literature, those of Saint Hilaire, Velpeau, and Acton. To these may be added the cases of Smith, Lange,[109] and Gleiss.[140] In the case of Velpeau the child had two penises, situated 4 cm. apart, a split scrotum each side containing one testicle, and, in addition, three lower extremities. Each penis contained a urethra, both of which functioned on urination. In the cases of Smith and Lange there was double penis, double urethra, and double bladder. In Lange's case there was, in addition, a double anal depression. A similar condition was described by Gleiss in a female child where there was double bladder, double labia majora, double vagina, and double rectum.

The etiology of this condition has already been discussed in connection with the etiology of double bladder. We must assume a longitudinal splitting of the vesico-urethral anlage with the continuation of the splitting through the cloacal tubercle and urogenital sinus. In those cases where the rectum is doubled it is apparent that the splitting must have affected the whole cloaca at a time before the urorectal septum had formed.

Dorsally Situated Accessory Urethral Canals.—A number of anomalies of this type have been described and scattered case reports are to be found through the literature. As a rule the normal urethra (lower canal) shows no abnormalities. The accessory canal lies above and courses parallel to the urethra, separated from it by the corpora cavernosa. Its orifice is situated above the external urinary meatus, usually on the glans or in the coronal sulcus, but may be situated on the shaft of the penis. In a few cases an epispadiac groove is found on the glans which continues backward into the orifice on the shaft. The canal of equal or smaller size than the urethra terminates in most cases blindly or in a small culdesac at the level of the lower border of the symphysis pubis (Fig. 560, I). Thirty-one cases of this type were collected from the literature by MacKenzie.[159] Less frequently the accessory urethral canal continues underneath the symphysis pubis to join

the bladder (Fig. 560, II). MacKenzie cites 6 cases of this type. Lissowkaja[155] reports 1 case in which the accessory urethra extended from the dorsum of the penis across the upper margin of the symphysis to the anterior wall of the bladder (Fig. 560, VI). In Cruveilhier's case[129] (Fig. 560, IV) the accessory urethral canal was said to follow the urethra to the base of the prostate, where it divided into two small channels which passed backward one on either side of the urethra to join the ejaculatory ducts. Ejaculation was described as taking place through the accessory canal, urination through the normal one. A case is reported by Luschka[158] in which the accessory canal is alleged to have had its origin in the anterior lobe of the prostate and to have opened to the outside by a funnel-shaped opening at the root of the penis (Fig. 560, V).

Numerous theories have been advanced to explain the etiology of the accessory urethral canals. It is agreed by most investigators who have studied this subject that no one theory satisfactorily explains both the dorsally and ventrally located canals. Different theories have been proposed for each of these types of anomalies, which, therefore, will be considered separately.

Luschka,[158] basing his ideas upon the cases which he described, concluded that the canals are displaced excretory ducts of aberrant prostatic lobes. Out of all the cases which have been described since Luschka's time, not a single other one has been found in which the canal was associated with a prostatic lobe. Other cases have been reported in which a secretion was obtained from the canal, but this has been explained as the product of smaller urethral glands.

Klebs[147] considered the dorsal canals as a manifestation of a healed epispadias. Lejars[153] proposed the interesting explanation that the canals are sinuses, caused by the failure of the two corpora cavernosa to unite completely; the dorsal portion of the intercavernous septum is not formed and a space is left between them, roofed above by the common connective sheath of the corpora. This view is no longer held tenable; it fails completely to account for the canals which extend into the bladder as well as for the urethral nature of the epithelial lining of the canals.

By Posner and Schwyzer[162] the accessory canals were considered to be exaggerated lacunæ magnæ. Lacunæ magnæ, however, are much smaller structures arising from the posterior portion of the fossa navicularis, and lie close to the urethra. It seems improbable, therefore, that there can be any connection between the lacunæ magnæ and the accessory canals which have their orifices on the glans or shaft of the penis and are separated from the urethra by the corpora cavernosa.

LeFort[152] and Delbet[130] independently concluded that the accessory canals were developed from the epithelial strand from which the urethra has its origin; by a dorsal proliferation and separation of a portion of it. Each of these two strands, which become separated by mesenchymal tissue, gives rise to a separate urethra. This view, modified as our knowledge of the development of the urethra has grown, has been followed by von Meyer,[160] Lebrun,[149] and Oudard and Jean.[161] The latter two authors believe that the anomaly is due to a continuation of the splitting process of the urorectal septum. Inasmuch as the accessory canals so closely simulate the urethra in their histologic structure, there can be very little question that they are both derived from the same anlage. There must, therefore, be a cleavage of the urethral anlage, partial or complete, as the case may be. The cleavage undoubtedly takes place at an early stage, before the corpora cavernosa have formed.

As a rule the accessory urethral canals give rise to no symptoms. The majority of cases have been discovered incidentally during the course of a gonorrheal infection. This is especially true of the blind forms. Having a structure and mucous membrane similar to the urethra, the accessory canals serve as an excellent location for the growth of the gonococcus.

Those accessory canals which extend into the bladder permit the escape of urine through them. As a rule the leakage takes place only during normal urination, at which time the urine passes through both openings, the stream from the accessory canal being the smaller. There may, however, be a partial incontinence, urine escaping from the accessory canal during exercise when the bladder is full. Cases of this type were reported by Lebrun[150] and Berger.[126] Ejaculation takes place usually through the normal urethra, but in Broca's case[127] it is described as coming from the accessory canal as well.

Ventrally Situated Accessory Urethral Canals.—Cases in which the accessory canals are located ventrally to the normal urethra are apparently of less frequent occurrence than those dorsally placed. Here again the anomaly presents varying degrees of completeness. The most common type is that in which the canal begins on the glans ventral to the normal meatus and continues backward a varying distance to join the urethra. The urethra, therefore, presents a forked appearance terminally, and in certain cases there has been doubt expressed as to which is the normal and which the accessory canal. The condition is justly spoken of as a congenital urethral fistula. The point at which the bifurcation of the urethra takes place varies from near the tip of the glans as far back as the bulbomembranous junction (case of Marion). In Rietz's case (Fig. 560, X) the external orifice of the accessory canal was found just in front of the penoscrotal angle. In the case of Jeanbrau[143] the accessory canal terminated blindly in a small culdesac; in Monod's case it is reported to have continued backward beyond the bulbous urethra and to have opened into the rectum (Fig. 560, III).

Several views have been proposed in regard to the formation of the ventral accessory urethral canals. Kaufmann believed that they are formed as true fistulæ from the perforation of the urethra due to a temporary occlusion. According to Rona[164] all accessory canals of the urethra are the result of the fusion of contiguous longitudinal folds with the cutting off and transformation of the intervening sulcus into a canal. Other investigators believe that they are formed at a time when the urethral gutter closes. When this structure is transformed into a canal and cut away from the overlying ectoderm, a small portion of the epithelium becomes detached and is transformed into a separate canal. Rietz,[163] in a consideration of a congenital penoscrotal urethral fistula (Fig. 560, X), concluded that the condition resulted from non-union at this point because of the development of oblique folds of the urethral gutter.

It is not difficult to understand how these ventrally situated canals and fistulæ might be formed from an anomalous closure of the urethral gutter. That the canals do form in this manner is substantiated by a case which Johnson[145] described and which is reproduced in Figs. 576, 577. Beneath the normal urethra is seen a second channel which is broken up into a number of segments. These structures are described as forming from the ventral wall of the urethra by proliferation. It seems more probable that they are the remains of a faulty closure of the urethra. Ehrmann[134] proposed the theory that the para-urethral ducts

(accessory canals) were formed from the broken-off remains of the mucosa of the urethra, but produced no embryologic evidence to substantiate his view. In regard to the above anomaly Johnson wrote: "It is difficult to conceive, however, that these ducts are para-urethral ducts in the making, for they show no external opening and are far more extensive than the usually described para-urethral ducts." Nevertheless one can easily perceive how, by a similar process,

FIG. 561.—Para-urethral duct on the surface of the glans. This duct harbored gonococci six months after the initial infection. After Johnson.

continuous ducts may form, with an external opening on the glans or behind it and with a urethral connection behind.

Para-urethral Ducts.—In reserving the term "para-urethral ducts" to designate those smaller anomalous ducts of the urethra which are found on the surface of the glans or in the meatus, it is fully realized that this term has previously been used to include all the accessory canals and ducts of the urethra. However, the ducts now under consideration differ markedly from the above described ac-

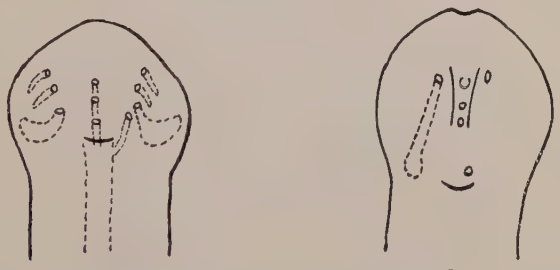


FIG. 562.—Two cases of hypospadias showing multiplicity of para-urethral ducts. A, Guyon's case; B, Churchman's case. After Churchman.[128]

cessory urethral canals in size, extent, and location. While their embryology has not been worked out, it seems improbable that they arise in a manner similar to the longer accessory canals, and for this reason they should be considered separately.

Churchman,[128] who has made a study of these ducts, states that they most frequently occur as small openings on the lips of the meatus or in the fossa navicularis. They may also be found on the glans occurring above, below, or lateral to the urethral orifice. As a rule they are only large enough to admit a small probe,

and of a length of 5 to 10 mm. They terminate blindly or in small culdesacs, but occasionally one is seen joining with the urethra, thus forming a fistula.

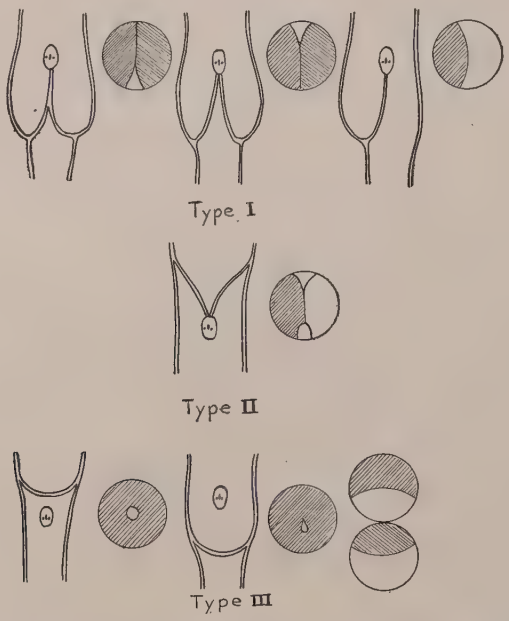


FIG. 563.—Various types of congenital valves of the posterior urethra. Opposite each type is shown the appearance obtained on urethroscopic examination. After Young, Frontz, and Baldwin.[173]

FIG. 564.—A congenital valve of Type I. After Young, Frontz, and Baldwin. Case of Knox and Sprunt.

Para-urethral ducts are most frequently seen in cases of hypospadias. In the cases described by Guyon and Churchman a variety of ducts were found, giving

to the hypospadiac meatus, as described by Churchman, a moth-eaten appearance (Fig. 562).

Nothing is known of the etiology of these structures, but, as stated above, it is not probable that they have a development similar to that of the longer accessory urethral canals. They are far more frequently seen, usually single, and brought to observation by becoming infected in the course of a gonorrheal infection. As Churchman states, they may be responsible for a persistent infection, offering a safe haunt for organisms.

Fig. 565.—Congenital valve of the urethra. Diagram from Lindeman, Inaug. Diss., Jena, 1904, showing the valves connected with lower portion of verumontanum and the obstructive changes above.

Congenital Obstruction of the Urethra.—Obliteration.—Various grades of this anomaly are occasionally seen in the newborn. The most frequent form is that in which there is a simple epithelial occlusion at the urethral meatus. The condition is accompanied by a phimosis with a failure of separation of the glans and prepuce. In other cases there may be a congenital absence of the glandular portion of the urethra. Kaufmann[146] has collected 10 cases of this type. More extensive degrees of obliteration than the above are recorded in the older literature. All portions of the urethra may be affected by the atresia. Eleven cases of extensive obliteration were collected by Kaufmann. These anomalies result in complete urinary retention of the fetus, with distention of the bladder, hydronephrosis, and

FIG. 566.—Congenital valve of the urethra. Both valves arose from the bifurcation of the crista urethralis. Note the dilated posterior urethra, the hypertrophied bladder, and the hydro-ureters.

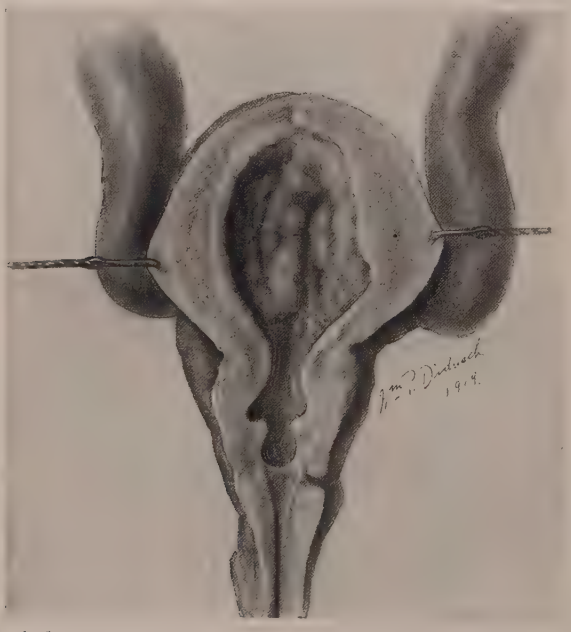


FIG. 567.—Congenital valve of the urethra. An example of the crescentic type of valve, varieties of which may be found at any level of the posterior urethra. Note the dilated posterior urethra, the hypertrophied bladder, and the hydro-ureters.

hydro-ureter. Two cases are cited in which the bladder was emptied by a vesico-rectal fistula.

CONGENITAL VALVES.—The most important type of congenital obstruction of

the urethra is one which is known as congenital valves. These are limited to the posterior urethra, usually in close relationship to the verumontanum. They are folds or duplications of the mucosa of the urethra, which, during urination, balloon out in

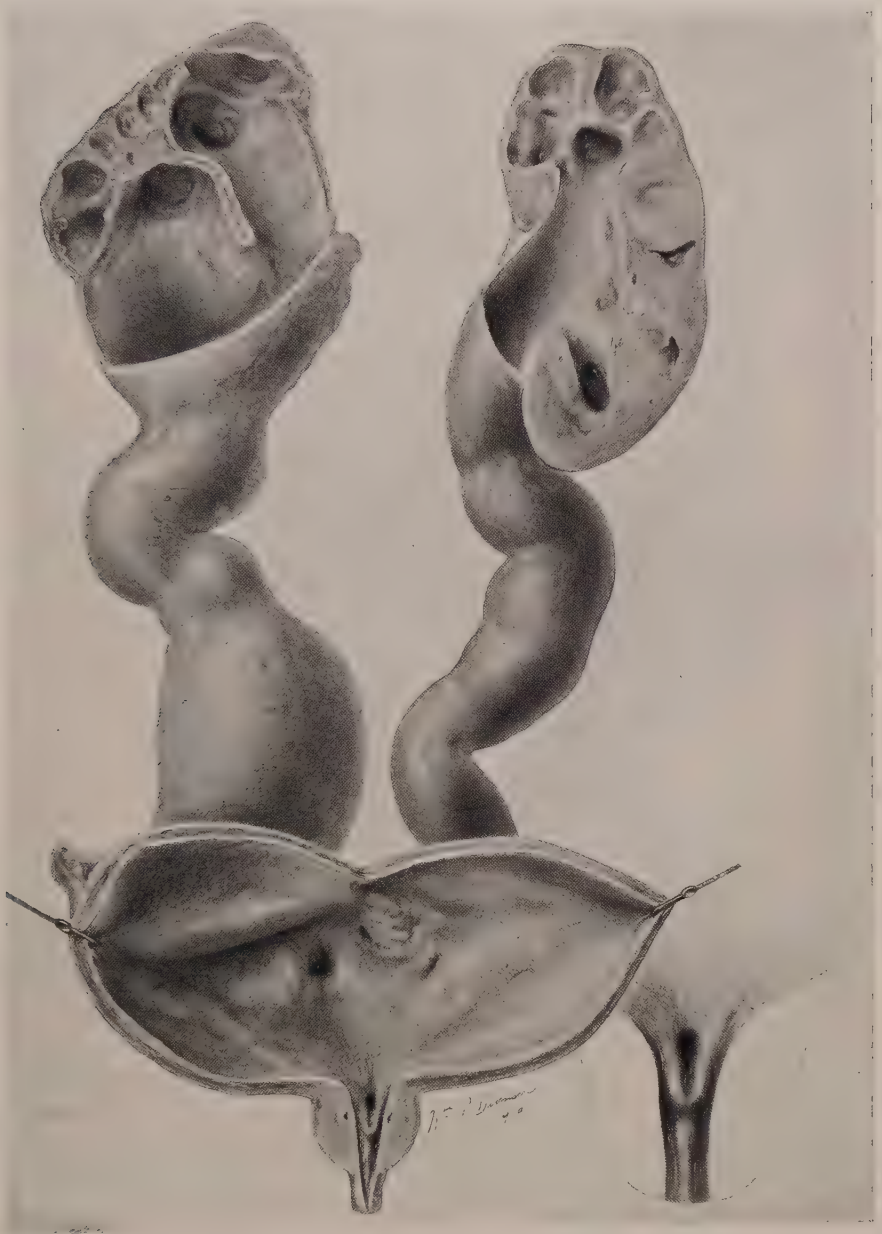


Fig. 568.—Autopsy specimen. Prostate opened in front, partly destroying valves, remains of which are shown. Bladder, ureters, and kidney pelves greatly dilated. Insert shows marked dilatation of sinus pocularis above urethral valves. B. U. I. 3404.

much the same way as do the valves of veins, and thus act as a definite hindrance to free urination. Only within recent years has the clinical importance of this anomaly been recognized and sought for as a cause in all cases of difficult urination in children.

Three definite types of the anomaly have been described by Young, Frontz, and Baldwin.[173] The first type is characterized by a ridge-like fold extending downward from the verumontanum and dividing into two membranous sheets. The outer edges of these sheets attach themselves to the rectal, lateral, and pubic walls of the urethra as they extend distally; the inner or free edges may or may not unite below (Fig. 563). In some cases of this type only a single unilateral valve is present.

In the second type of valve a ridge similar to that of the preceding type is found, but it passes upward from the verumontanum and divides into two valve-

Fig. 569.—Cysto-uretero-pyelogram after injection of 600 c.c. of 15 per cent. thorium nitrate into bladder. Note the dilated posterior urethra and vesical orifice, the irregular bladder outline, and the greatly distended ureters and kidneys.

like folds which are attached to the urethra just outside the urethral sphincter. The third type is a more or less disc-shaped valve the outer edge of which is attached to the entire circumference of the urethra; a small opening toward its center alone prevents complete urinary obstruction. The latter type of valve may be found in any portion of the posterior urethra and bears no relationship to the verumontanum.

In all three types there is usually a dilatation of the urethra above the valves; if the obstruction is marked there is also a dilatation of the internal sphincter. The bladder may or may not be dilated; its wall is usually greatly hypertrophied.

Hydro-ureter and hydronephrosis are of common occurrence as a result of the long-continued back pressure.

No figures are available in the literature regarding the frequency of congenital valves. Twelve cases of the condition were studied by Young, Frontz, and Baldwin from the records of the urological and pediatric services of the Johns Hopkins Hospital. The same authors were able to collect only 23 additional cases from the literature. An analysis of these cases shows 16 to be of Type I, 1 of Type II, and 9 of Type III. The age incidence is as follows: under one year, 12 cases; one to ten years, 9 cases; eleven to twenty years, 5 cases; over twenty years, 4 cases. The oldest was in a man of eighty-five years. A more recent study of congenital valves is afforded by the work of Hinman and Kutzman,[142] who, in addition to recording 6 cases of their personal observations, collected 50 cases from the literature.

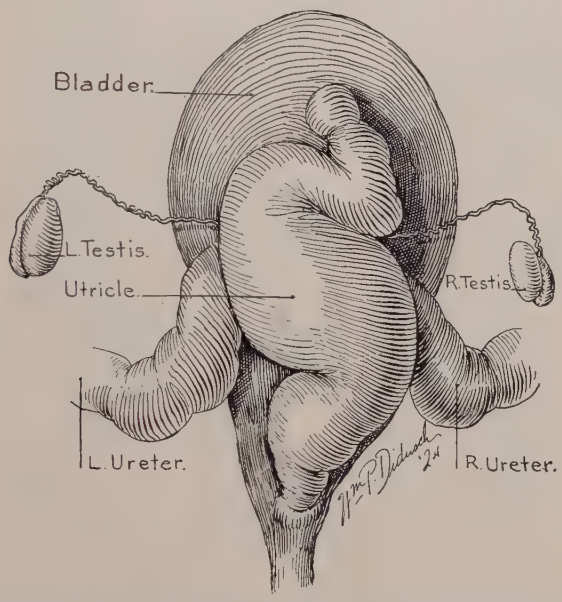


FIG. 570.—Congenital valve of the urethra. Redrawn from Tolmatschew, Archiv für Pathologische Anatomie, 1870. In this case the valve formation in the urethra below the verumontanum was associated with a remarkable anomaly of the utriculus which, undoubtedly larger than normal to begin with, became filled with urine and took part in the generalized dilatation of the urinary tract. The dilated ureters are also shown.

Several theories have been proposed to explain the etiology of congenital valves. Tolmatschew[167] believed them to be a simple modification and enlargement of the folds and ridges which are normally present in the prostatic urethra. This view was accepted by Lindeman,[154] Wilckens,[172] and Englisch.[138] Bazy[125] believed that the valves represent a persistent urogenital membrane, contending that this structure would occupy in the later stages of development a position corresponding to the most frequent site of the valves. This view was accepted by Thompson,[166] Lederer,[151] and Knox and Sprunt.[148] It will not, however, bear close scrutiny. In the first place the urogenital membrane belongs to the pars urogenitalis of the urethra, and not the pars pelvina in which the valves are found. Second, it is never of the form of a diaphragm or folds, but is a narrow plate of epithelium which is placed in the mid-sagittal plane. Moreover, it is entirely epi-

thelial in nature, and is not composed of an epithelial covered fibrous sheet as are the valves in question.

According to Young, Frontz, and Baldwin,[173] none of these views seems adequate to explain all types of the anomaly. They admit the plausibility of Lowsley's and Tolmatschew's views as an explanation for the valves of Type I and Type II and of Bazy's for Type III. They attach importance to a figure of a single section of the urethra of a fetal stage published by Watson,[169] which they believe to be a valve in the process of formation. More recently Watson has expressed his belief that the same specimen gives the clue to the etiology of congenital valves. This specimen is alleged to have an anomalous "attachment of the tip of the colliculus to the roof of the urethra and occurs at a time of marked epithelial activity of this and associated parts" (Fig. 571). He believes that this fusion is preceded

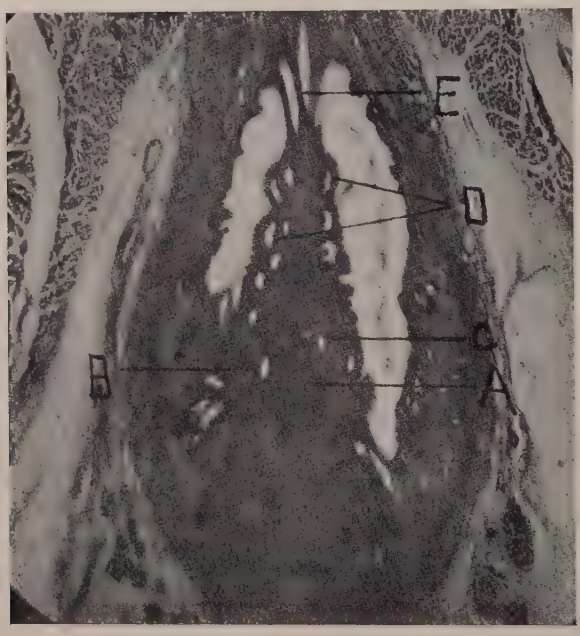


Fig. 571.—Section of the verumontanum of a fourteen-week-old fetus. Watson describes the verumontanum (C and D) as having a fibrous connection with the roof of the urethra, which traverses the lumen of the urethra. After Watson.[169]

by a stage in which the epithelium of the urethra becomes broken up, thus favoring the above-described fusion. Too much importance, however, should not be attached to this one fetal stage. Studies on the development of the urethra fail to show a "fragmentation" of the urethral mucosa that could not definitely be charged to poor preservation of the tissues. Moreover, it is unfortunate that Watson did not model such an important specimen, for then the true relationship of the "developing valves" could be plainly seen. It may be pointed out that it is possible to obtain similar figures to those of Watson from the normal urethra. Figure 572, G represents a section from a normal series closely resembling that furnished by Watson. A study of the complete series shows that this is a tangential section through the verumontanum (compare with Fig. 572, A). It would appear, therefore, that what Watson has described as a fusion of the veru to the

roof of the urethra is nothing more than the attachment of the inferior portion of the verumontanum along the floor of the urethra.

It is evident from an examination of the cases reported by Young, Frontz, and Baldwin that there is a considerable variation in the shape and position of the valves of any one type. We would expect, therefore, to find their beginnings in some variable structures rather than in one as constant as the urogenital membrane. Such structures are to be found in the mucosal folds of the urethra. They occur at both upper and lower ends of the verumontanum as is shown in Figs. 555 and 557. They vary in size and number; those of the lower end of the prostatic urethra have a tendency to course downward and forward (Fig. 557). Should these folds become enlarged it is conceivable that they might act as a partial obstruction to urination. And once obstructing the urinary outflow, each

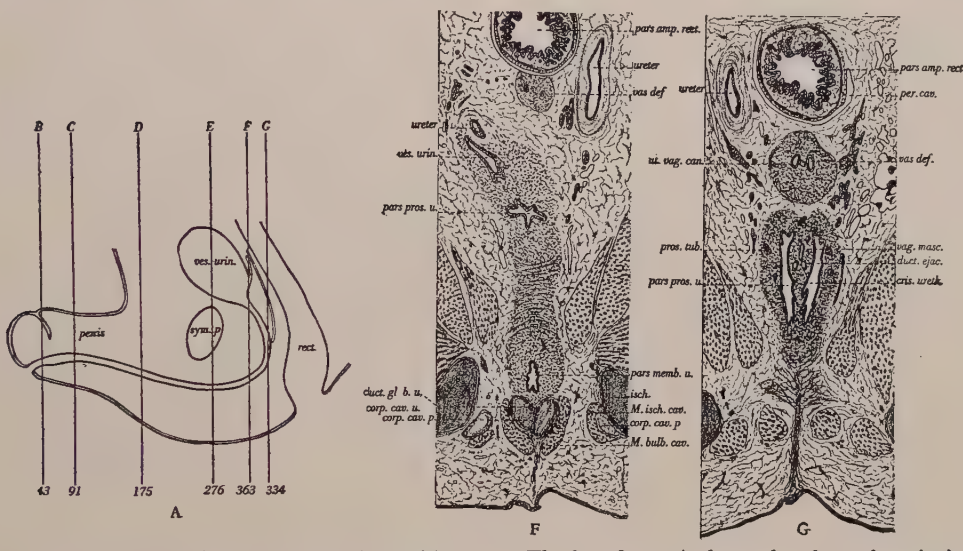


FIG. 572.—Sections from an embryo of 75 mm. The key figure A shows the plane of sectioning of F and G. The verumontanum has a similar connection as shown by Watson in Fig. 571 (reverse the figure). This, it is contended, is a tangential section of the floor of the urethra, and what Watson has described as a connection between the veru and floor of the urethra is merely the attachment of the inferior prolongation of the crista urethralis to the floor. The roof of the urethra does not show in the section at all. After Johnson.[144]

passage of urine would tend to mold them more and more into valve-like structures. Even the diaphragmatic valves might be formed in this manner. Summing up, therefore, it would appear that the older view of Tolmatschew has more in its favor from an embryologic viewpoint than any of the other views proposed.

The *symptoms* of congenital obstruction of the urethra are, according to Young, Frontz, and Baldwin,[173] characteristic. Those referable to the local obstruction are incontinence, dysuria, and retention. The bladder becomes dilated and a distended abdomen is the most common complaint in these cases. The back pressure on the kidneys results in lowered renal function. When the disease reaches this stage the symptoms are those of chronic diffuse nephritis; nausea and vomiting, diarrhea, loss of weight, edema, etc., death occurring in some cases from uremia. The susceptibility to renal infection is marked; its presence is evidenced by fever, chills, anorexia, loss of weight, etc.

The history of incontinence of the paradoxical type and distended abdomen in children is important in the diagnosis. In the less severe grades of the obstruction the urinary stream is small and weak; diurnal frequency of urination and enuresis are common. By manual palpation one can make out the distended bladder, hydro-ureter, and hydronephrosis. The obstruction can generally be demonstrated by a small catheter, the valve-like folds offering in many cases no obstruction to the free passage of the catheter. Yet retrograde passing of the catheter at operation meets with failure because of the nature of the valves. Cystoscopic examination may reveal trabeculation, diverticula, and dilated ureteral orifices. The dilated vesical orifice and prostatic urethra may also be demonstrated. Cysto- and urethrograms are invaluable in definitely locating the position of the valves.

The *treatment* of cases of obstruction to urination resulting from congenital valves of the prostatic urethra or other forms of congenital obstruction in the posterior urethra in male or female, depends largely on the condition of the patient and the pathology of the local lesion. Many of these cases are characterized by long-standing obstruction to urination with back pressure and the concomitant lesions and complications. The same care will have to be taken as in cases of prostatic hypertrophy with similar obstruction and back-pressure effects. The dilatation of ureters and kidney pelves and the thinning of the renal cortex is far greater than even in the most serious cases of prostatic back-pressure. When first seen the renal function is usually extremely poor, the percentage of phthalein secreted very low, often only a trace, and the non-protein nitrogen high. On physical examination the distended bladder, ureters, and kidney pelves can usually be palpated, and one will recognize at once the necessity for avoiding immediate complete deflation by catheter or suprapubic drainage. For the same reason cystoscopy accompanied by immediate evacuation of the bladder should not be carried out. It is best, at first, to pass a small catheter to evacuate a small portion of the urine and to attach immediately a decompression apparatus as described in the preoperative treatment of prostatic hypertrophy, or to accomplish the same result by having a catheter running over a height so as to prevent complete evacuation of the bladder and consequent danger of uremia. Passage of the catheter may be difficult, owing to the fact that the tip may catch in the pouch in front of the valve or in the substance of the verumontanum. A stylet may often be necessary when using a small rubber catheter and in some cases a ureteral catheter is the most satisfactory instrument to be used. Sometimes filiforms and followers may be required to penetrate the slit-like orifice between the valves. Having introduced catheter drainage, the pressure is gradually reduced and forced hydrotherapy, digitalis, and other methods to combat and prevent uremia are undertaken. When the patient has improved sufficiently so that drainage against pressure is not necessary, further study of the case may be carried out.

Before removing the catheter it is well to do a cystogram and in most cases ureterograms and pyelograms are also obtained as the fluid flows without obstruction up into the higher urinary passages and gives wonderful pictures of huge dilatation as seen in shadowgraph and *x*-ray plates shown elsewhere. In studying the cystogram one should carefully observe the urethral orifice for dilatation of the internal sphincter, as shown in the accompanying cystograms (Fig. 569), as marked dilatation of the prostatic urethra above the site of the valve when once made out points surely to the site of obstruction. A baby cystoscope (No. 12)

may easily be introduced through the urethra of very young infant boys, the only difficulty being the passage through the opening between the valves. When this has been successfully accomplished, study of the posterior urethra usually gives a very interesting picture and shows with great clearness the arcuate border of the valve and the dilated pouch-like urethra above it. Study of the bladder will also show the character of the ureteral orifices, which are often dilated, trabeculation, cystitis, and so forth.

Before removing the cystoscope one should carefully plan the operation for the cure of the obstruction. In case it is impossible to pass a cystoscope through the valves, a very minute endoscope, which we have made, can be used and a view of the external surface of the valves obtained. Such procedure may be necessary in some cases to find the orifice, and a filiform may then be passed, followed by instrumental dilation.

Operative treatment of the valves, as indicated above, depends largely upon the condition present. In some cases they may be ruptured by the instruments, filiforms, sounds, and so forth. When a passage-way has been procured, further dilation by use of sounds may be sufficient to rupture or greatly dilate the obstructing valve and completely remove the difficulty of urination, but, as a rule,

FIG. 573.—Baby punch instrument. Specially constructed to remove valves of prostate. A, Photograph of specimen (valve) removed in case of child aged two; recovery; apparent cure.

such treatment results only in temporary dilatation and does not cure, and a method to remove the obstruction completely is indicated.

Suprapubic Operation.—In our first case this was carried out; in fact, the discovery of the lesion was first made by us in a suprapubic operation done for drainage. In that case we found the prostatic orifice widely dilated and were able to palpate the valve behind on the end of the sound which was caught in the pouch beneath it. Wide division of the valve with scalpel behind the end of the sound was then made, completely removing the obstruction and curing the patient. This is a very satisfactory method of handling such cases.

Perineal Removal of Valve.—This may be easily accomplished even in small children, the prostate being opened and the valve exposed behind the triangular ligament by much the same procedure as for perineal prostatectomy. This method was illustrated in a former paper,[173] but both the perineal and suprapubic methods are usually unnecessarily major in character.

Removal with a Baby Punch.—This has been carried out in a recent case (B. U. I. 8555) in a boy seven years of age. In this case the cystoscope showed the valve. A special "baby punch" No. 17 F. in size (Fig. 573) was made in our shop and used to remove the valve through the posterior urethra. The instrument was first

placed in the bladder, the obturator withdrawn, and the instrument gradually pulled out until the valve was caught in the fenestra. The field was then dried. With endoscopic light attached the valve was distinctly seen and filled the entire field of the instrument. The inner cutting tube was then inserted and the valve at once removed in one piece, after which the larger instruments could be passed with ease. This method was very satisfactory in the case employed. Whether it could be used in other early stages which we have seen is a question, but we believe minute punches can be made for babies but a few weeks old, or some other design of instrument with a hook which can catch the valve and a sliding tube which will cut it away can be devised. In conclusion it may be said that the simplest method is to eradicate completely the valvular obstruction, and in our opinion this can be accomplished by urethral instruments, thus doing away with the necessity for either suprapubic or perineal operations.

Results of Treatment.—In our paper[173] previously referred to 23 cases were collected from the literature. Of these, 22 died and the anomaly was discovered postmortem. Two of the cases were treated by suprapubic cystostomy, no preoperative diagnosis being made. One case was treated by catheterization, without operation, and in none of the 23 cases was any operation carried out for the cure of the valvular obstruction. In the only case of the 23 that got well, Posner, in 1907, found obstruction, as he thought, in the bulbous urethra and was able to pass a catheter, rupturing the obstruction and curing the patient. This was almost surely a case of congenital valve of the prostatic urethra and is the only case in the literature in which the patient got well, this being accidental.

The first case in which a congenital valve of the prostatic urethra was cured by operation was that of a patient who came to this clinic on August 25, 1913. He was twenty months old and had from birth suffered from great difficulty and frequency of urination. On examination a greatly distended bladder was discovered. Attempts to pass catheters and sounds were unsuccessful, owing to an obstruction deeper than the external sphincter, and thought to be at the prostatic orifice. A filiform was readily passed into the bladder, after which a ureteral catheter was passed and a large amount of residual urine was recovered in this way. The phthalein showed only a trace for the first two and one-half hours and only 30 per cent. for six hours. A thorium cystogram showed dilatation of the prostatic urethra and a diagnosis of obstruction in the anterior part of the prostatic urethra was made. October 13, 1913: Operation, Young; suprapubic cystostomy. The vesical orifice was found to be dilated and just beyond it in the prostatic urethra was a small vertical valve-like obstruction which was semilunar in outline, and extended from the floor to the roof. It was readily seized by a clamp, pulled into the bladder, and destroyed with electrocautery. After that instruments could easily be passed from the meatus into the bladder. The valve had been completely destroyed. The patient made an excellent recovery.

This case was reported before the Johns Hopkins Hospital Medical Society in November, 1913 and was apparently the first clinical recognition and operative cure of congenital valve of the prostatic urethra.

Our records to date comprise 17 cases, 12 of which have been previously reported and 5 more recent ones. Four of these patients entered the hospital in uremia and died promptly. One died a month later while on catheter drainage. In the other 12 cases operations were carried out with removal of the obstructing valve, with

success in every instance. As these are apparently the only cases in the literature where this disease causing a very serious pathologic condition has been combated by surgery with success, it seems worth while to present them in tabulated form.

TABLE 140

CONGENITAL VALVES, AGE

Years.	Cases.	Per cent.	
0– 5	8	47	82
5–10	4	23	
10–15	2	12	
15–20	1	6	
20–30	1	6	
30–40	0		
40–50	1	6	

Oldest forty-two years—youngest eleven days.

TABLE 141

CONGENITAL VALVES, SYMPTOMS

	Number.	Per cent.
Frequency	7	41
Diurnal incontinence	3	18
Nocturnal incontinence	5	30
Dribbling	1	6
Dysuria	7	41
Attacks of retention	3	18
Distended bladder	5	30
Residual urine	10	59
Vomiting	3	18
Loss of weight	2	12
Hematuria	1	6

TABLE 142

CONGENITAL VALVES, METHOD OF TREATMENT AT BRADY UROLOGICAL INSTITUTE

Suprapubic cystotomy with destruction of valves	4
Punch operation	4
Suprapubic cystotomy and punch operation	2
Suprapubic cystotomy and external urethrotomy	1
Rupture of valves per urethroscope	1
Exploratory laparotomy	1
No operation	4

TABLE 143

CONGENITAL VALVES, RESULTS OF CASES TREATED AT BRADY UROLOGICAL INSTITUTE

		Per cent.
Cured	9	54
Improved	3	17
Dead	5	29

Résumé.—Of the 17 cases comprising this series, 12 were operated on, 9 being cured and 3 markedly improved. Four cases were not operated upon. Four died shortly after admission, 1 after an exploratory laparotomy. One died of renal insufficiency after being in hospital about one month.

TABLE 144

Congenital Valves

Case number.	Date.	Age.	Symptoms.	Clinical examination.	Diagnosis.	Treatment.	Operative findings.	Autopsy findings.	Result.	Remarks.
1	5/18/12	12 years.	Difficult and frequent urination since birth.	Large residual urine; pyuria. Obstruction to catheter, posterior urethra, cystogram; reduced renal function.	Congenital obstruction.	Suprapubic cystostomy with destruction of valve; rongeur.	At about level verumontanum; crescentic band across roof of urethra.		Well.	
2	11/11/12	17 years.	Urinary difficulty since birth.	Residual urine, pyuria; urethroscope shows 2 thin valves springing from crista urethralis.	Urethroscopy; congenital valves in posterior urethra.	Rupture of valves per urethram; urethroscope.		Remains of valves (Type 2) previously destroyed. Enlarged utricle, bilateral hydro-ureter, and hydronephrosis.	Well.	Patient died of pneumonia 1 year later; see autopsy findings.
3	1/25/13	2 years.	Attacks of complete retention.	Residual urine.			One valve below verumontanum springing from lower end crista urethralis, left side.		Dead.	
4	8/19/13	21 months.	Painful urination for 10 months. Periodical attacks of retention.	Distended bladder; obstruction to catheter in posterior urethra; residual urine.		Suprapubic cystotomy with external urethrotomy, with rupture of valves; sounds.	Three membranous folds below verumontanum.		Well.	
5	8/25/13	20 months.	Urinary difficulty and pain.	Distended bladder; palpable mass each kidney region; reduced renal function; x-ray to demonstrate the point of obstruction.	Congenital obstruction posterior urethra.	Suprapubic cystotomy with destruction of valve; clamp and cautery.	Just below vesical orifice vertical valve on left side.		Well.	Died 1 year later of diphtheria.
6	7/14/14	6 months.	None until 2 days before admission, then abdominal distention.	Catheter met with obstruction at external sphincter.		Suprapubic cystotomy with rupture of valve in posterior urethra with finger.	Valve in midportion prostatic urethra.		Well.	
7	3/1/16	11 days.	Vomiting, abdominal distention; urinary retention.	Distended bladder; obstruction to catheter.	Abdominal tumor.	Exploratory laparotomy.	Mesenteric and urachal cysts.	Division crista urethralis below verumontanum into 2 valves.	Dead.	
8 B. U. I. 4938	3/17/16	26 years.	Dysuria and urinary frequency for 9 years.	Residual urine; pyuria, urethroscope shows 1 valve below verumontanum springing from crista urethralis.	Urethroscopy; congenital valve in posterior urethra.	Excision of valve with "punch."	Single valve on right side of urethra below verumontanum.		Well.	Excision followed by partial incontinence.
9	7/30/16	15 months.	Loss of weight; vomiting.	Distended bladder; pyuria. Residual urine; reduced renal function.				Two valves below level of verumontanum.	Dead.	

CONGENITAL VALVES (*Continued*)

10 B. U. I. 6530	6/2/17	42 years.	Urinary difficulty since early childhood. Frequency; nocturnal enuresis.	Residual urine; pyuria; urethroscope shows 2 valves springing from verumontanum running toward external sphincter; reduced renal function.	Urethroscopy; congenital valves posterior urethra.	Excision of 1 valve with "punch."	Bilateral valves of urethra below verumontanum.		Well.	Marked improvement.
11	10/15/17	3 months.	Loss of weight and vomiting.	Pyuria.				Specimen destroyed.	Dead.	
12	12/8/17	4 years.	Dysuria. Persistent suprapubic fistula.	Pyuria; a persistent suprapubic fistula (postoperative).	Contracture of vesical neck.	Suprapubic cystostomy with passage of large sounds.			Well.	
13 B. U. I. 8555	2/24/20	7 years, 11 months.	Frequency, dribbling, enuresis.	Bladder to umbilicus. Residual 290 c.c., 30 c.c. massaged from left ureter. Valves of posterior urethra connected with verumontanum.	Congenital valves.	Punch operation (special No. 17 punch). Valve and part of verumontanum removed.			Well.	Within a few days voiding only 3 to 4 times during the day and holding urine 10 hours at night.
14 B. U. I. 8727	4/26/20	7 years.	Incontinence, diurnal and nocturnal. Frequency.	Pyuria. Residual 200 c.c. Congenital valves of posterior urethra.	Congenital valves.	Suprapubic cystotomy. Punch operation. Passage of sounds.	Congenital valves, dilated prostatic urethra. Iris valve.		Well.	Sinus healed promptly. Urinating normally in 4 weeks. No residual. Excellent result.
15 B. U. I. 9023	8/17/20	10 years.	Incontinence, diurnal and nocturnal.	Residual 550 c.c. Dilatation of posterior urethra (*x*-ray).	Congenital valves.	Suprapubic cystotomy, rupture of valves with sounds. At a later date punch operation.	Congenital valves. Dilated posterior urethra.		Improved.	The suprapubic sinus persisted until July, 1924. Voids 8 to 10 times day and 2 to 4 times night. Passes as much as 16 ounces at one time.
16 B. U. I. 10,155	12/6/21	9 years.	Frequency. Incontinence (diurnal).	Internal orifice dilated. Valves running upward from each side of verumontanum.	Congenital valves of posterior urethra.	Punch operation. Dilatation of urethra with sounds.	Congenital valves.		Improved.	Capacity 4 to 8 ounces (before operation 60 c.c.). Dribbling during day, continued if active.
17 B. U. I. 12,427	5/24/24	15 years.	Nocturnal incontinence. Hematuria. Frequency.	Mitral regurgitation. Distended bladder. Residual 260 c.c. Valves of posterior urethra. Bifid ureter and pelvis, left hydronephrosis. Right hydro-ureter and hydronephrosis. Hourglass type of bladder.	Congenital valves posterior urethra. Dilated posterior urethra. Hydronephrosis right. Slight hydronephrosis left.	Retention catheter. Blood transfusion.		Congenital diverticulum and obstruction of urethra. Pyelonephritis and cystitis.	Died. 7/7/24.	Entered hospital in poor condition.

Diverticula and Cysts of the Urethra.—Under the term "diverticula of the urethra" have been described a great variety of pouches. Some of these are considered to be congenital, others acquired; some are merely bulbous expansions of the urethra, others are true epithelial-lined pouches; still others are merely false passages made during improper instrumentation of the urethra. Watts[170] recognizes two types of acquired diverticula (*a*), those arising from dilatation of the urethra resulting from urethral calculus and urethral stricture; (*b*) those arising from perforation of the urethra resulting from injuries of the urethra, ruptured abscesses into the urethra, and ruptured cysts of the urethra.

Of the 16 cases of the congenital type of urethral diverticula which Watts collected, 12 were found to be connected with the pendulous urethra; 2 were found presenting in the perineum; 1 within the scrotal sac; and 1 at the penoscrotal junction.

In 1908 Ehrlich[133] collected 32 cases of congenital diverticula. Two of the cases cited by Watts, however (those of Schüter and Petz), are not included in this list. To this list Johnson[145] added 4 more cases, making a total of 38 cases.

Several theories regarding the formation of congenital urethral diverticula have been advanced. Kaufmann[146] believed that there was a failure to unite of the two portions of the urethra, the glandular and penile. This failure occluded the urinary outflow and resulted in a distention of the urethra. Subsequently when the urethra became patent the distended portion remained as a diverticulum. According to Voillemier[168] diverticulum and hypospadias formation are to be placed in the same category, the difference being that in the former only the urethra is at fault, while in the latter the defect extends through and includes the skin. DePaoli[131] explained the formation of diverticula as due to a primary atrophy of the corpus cavernosum urethræ, with a consequent bulging of the urethral mucosa into the cavitation thus made on its ventral wall.

Fig. 574.—Congenital diverticulum of the cavernous urethra. Case of Laugier. After Kaufmann.[146]

Watts states that since acquired diverticula are usually the result of obstruction to the urinary outflow, some similar obstruction should be sought for in the explanation of the congenital ones. He says that such obstructions could be caused by adhesions of the prepuce to the external meatus, congenital strictures of the urethra, or by the presence of valves within the urethra. However, he does not believe the findings in cases of congenital diverticula bear out this view. Englander[136] supports the view of Voillemier that there is a faulty union of the folds of urethra. Young and Shaw report a diverticulum after perineal prostatectomy.

In Fig. 576 is shown how faulty union of the urethral gutter may result in the formation of a segmented tubular structure along the ventral surface of the urethra. The opinion has elsewhere been expressed that the accessory canals found ventral to the normal urethra are formed by a similar process. A glance at the figure will be sufficient to show how cysts and diverticula of the urethra may develop from these tubular structures.

References in the literature to cysts of the urethra are rarer than those of diverticula, and those which have been found deal with cysts of the ducts of Cowper's glands. These cysts arise because of obliteration of the mouths of the main

ducts and therefore lie just beneath the mucosa of the bulbous urethra. Englisch[137] described 5 cases of this kind found in adults and in the newborn. The cysts were small and presented themselves as bulgings into the floor of the urethra. In 1 case

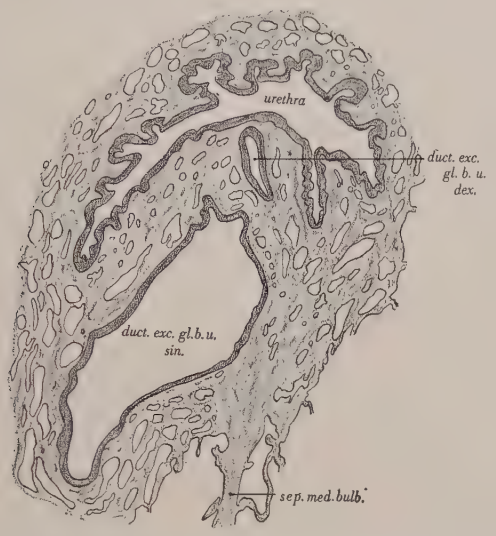


FIG. 575.—Cyst of Cowper's gland duct. The mouth of the left duct is entirely obliterated and the duct is dilated. Fetus of 310 mm. in length. After Johnson.[145]

there were two greatly elongated cysts, bilaterally placed and separated from one another by only a thin wall of tissue. In all of his cases Englisch showed that there was obliteration of the ducts of Cowper's glands.

FIG. 576.—An anomaly of the urethra of an embryo 88 mm. in length. Lines A and B indicate the level of the sections shown in the following figure. After Johnson.[145]

Elbogen[135] published a list of 16 cases of cysts of Cowper's glands which he found in routine autopsy examination. In age these ranged from infancy to old age. They varied greatly in size, from a few millimeters in diameter to 6.5 cm.

All cases were shown to be due to the occlusion of either one or the other of the ducts of Cowper's glands.

To these cases Johnson[145] added 3 more, 2 of which were found in fetal stages of 310 and 320 mm. respectively. The latter showed marked dilatation of the terminal portion of the main duct of the gland (Fig. 575). From the serial sections of these specimens it was easy to make out complete atresia of the mouths of the ducts.

One case was found in a negro of twenty-two years of age and was remarkable for its great size. The patient from early infancy had had a mass in the scrotum. It occupied the middle of the scrotum, the testicles being placed in separate compartments on either side of it. At first as large as an egg, it gradually grew to be as large as a grape-fruit. It was removed at operation, when its relation to the left Cowper's gland was discovered (Fig. 578).

Cysts of the posterior urethra have recently been studied by Wesson. These have their origin, as a rule, in the prostate though they may arise from the sub-

FIG. 577.—Cross-sections of the specimen shown in Fig. 576. After Johnson.[145]

trigonal or Albarran's glands. Wesson[171] has analyzed 29 cases found in the literature. The age incidence ranges from thirty years to old age, although 1 case was found in a child of one and three-quarters years. With the exception of the latter case these cysts should probably all be classified as acquired retention cysts rather than congenital.

Hypospadias is that malformation of the penis and urethra in which the external urinary meatus is located at some point proximal to its normal situation, but always on the ventral wall of the urethra. All gradations of the anomaly have been observed, from an opening on the glans immediately behind the normal site to one situated in the perineum. Thus several anatomic varieties are to be distinguished depending upon the position of the orifice. Fowler[177] states that as many as 11 varieties have been described, but he himself includes all cases in three main groups, the balanitic (glandular), penile, and perineal (perinoscrotal). Nové-Josserand[182] described four types as follows: balanitic (subdivided into meatal and submeatal), penile, scrotal, and perineal. In the account here given the following

classification has been employed: glandular, penile, penoscrotal, scrotal, perineal, and pseudovaginal (Fig. 579).

Glandular Variety.—In this form the urethra opens on the ventral surface of the glans, the opening occupying any position between the normal situation and the coronal sulcus. In some cases the orifice may be merely the prolongation of the normal orifice, cleft-like in shape. In others it opens in the region of the frenum as a more rounded or V-shaped orifice which is often atresic. In these cases the normal site of the meatus may or may not be marked by a blind depression several millimeters in depth. The under surface of the glans is sometimes marked by a shallow groove or deeper sulcus extending from the orifice to the tip of the glans. This sulcus is lined with a mucous membrane similar to that of the urethra. In it one can sometimes find a depression corresponding to the valve of Guerin. In addition, other smaller depressions are frequently seen; these are regarded as para-urethral ducts by Churchman,[128] but, according to Nové-Josserand, correspond to the lacunæ of Morgagni. In still other cases the sulcus may be entirely closed over, forming a canal which terminates blindly before it reaches the tip of the glans, or actually opening to the surface at the normal site of the urethral orifice.

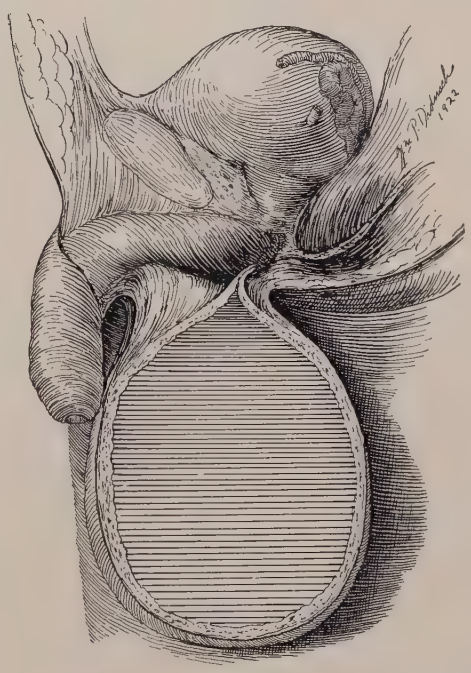


Fig. 578.—A large cyst of Cowper's gland duct which occupied the median septum of the scrotum. After Johnson.[145] B. U. I. 10,930.

In glandular hypospadias the glans is broadened and flattened dorsoventrally, and slightly rotated downward. A normal frenum is lacking, the ventral folds of the prepuce being attached more laterally than normal. Between these folds the tissues are sometimes indurated and apparently cicatricial. The prepuce does not cover the dorsum of the glans. It is, however, hypertrophied and thrown into a number of characteristic transverse folds. Because of its wide-spread attachments on the ventral surface of the penis, it resembles the prepuce of the clitoris and is universally described as "hood-like" in appearance.

In glandular hypospadias the malformation as a rule affects only the glans, urethral orifice, and prepuce. In exceptional cases it may be accompanied by those other deformities which are found constantly in the more severe grades of hypospadias.

Penile Variety.—This form is characterized by the situation of the urethral orifice at some point on the ventral surface of the penis between the glans and the penoscrotal angle. The orifice may be rounded or U shaped; it may be sufficiently large to allow for a free flow of urine or it may be small and atresic. As in the glandular form, there is usually a groove of variable depth which extends

from the abnormal orifice almost to the tip of the glans. The groove is lined with a modified mucosal layer and its surface is oftentimes finely pitted. On palpation the borders are felt to be indurated and erectile, due to rudiments of the corpus cavernosum urethræ contained beneath. The urethral groove, however, may be entirely lacking. Then, as in the glandular type, there may be no evidence of the urethra beyond the orifice, or there may be a well-defined canal which either terminates blindly in the glans, or opens to the outside at the normal site of the

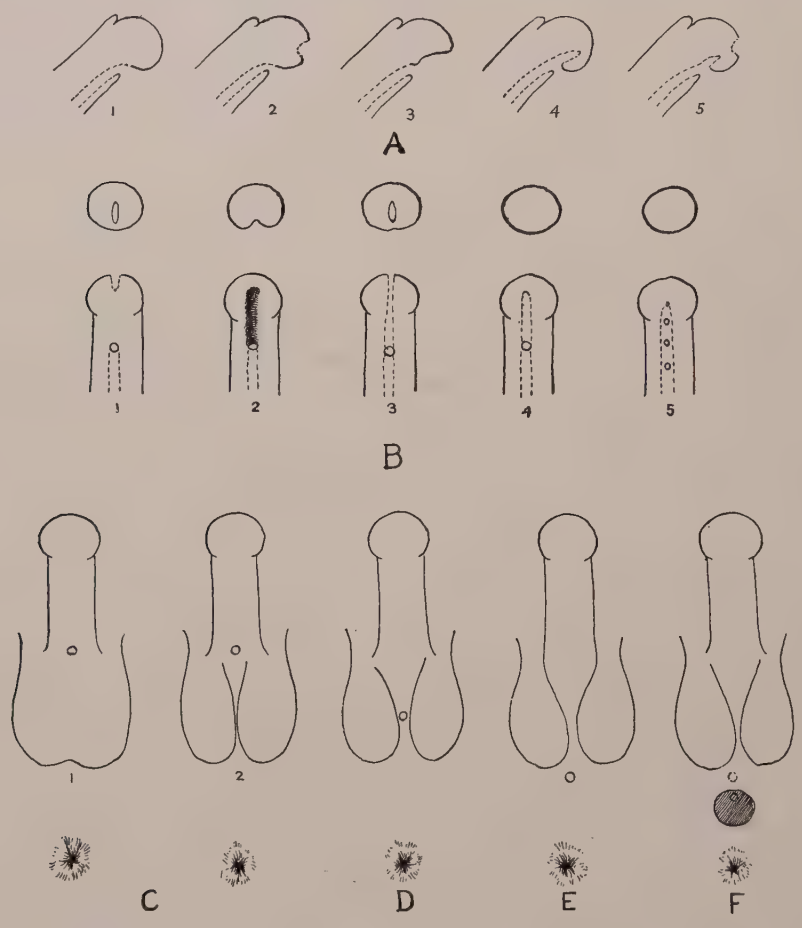


Fig. 579.—Varieties of hypospadias: A, Glandular; B, penile; C, penoscrotal; D, scrotal; E, perineal; F, pseudovaginal. The penoscrotal variety may have either the normal or bifid type of scrotum. In the pseudovaginal type the urethral orifice may be located in the vagina-like pouch or on the perineum.

meatus. Cases of this kind have already been considered under the caption of "accessory urethral canals."

In penile hypospadias there is always a deformity of the glans and prepuce. The glans is broadened and tilted forward, the prepuce redundant, retracted, and hood-like in appearance. In addition, there is always a varying degree of congenital chordee present, the amount being usually greater the further back the situation of the orifice. This incurvation, which is noticeable in the flaccid state, becomes much more pronounced when the penis is erect. In certain cases there exists a

fold of skin lying in the sagittal plane which attaches the ventral surface of the penis to the raphé of the scrotum; this condition is spoken of as "la palmure" by the French authors.

Penoscrotal Variety.—In the penoscrotal variety of hypospadias the urethral orifice is found in the penoscrotal angle. The glans, prepuce, and shaft of the penis are similar to those of the marked penile variety. The congenital chordee is very apparent. The scrotum may be normal, but more often shows a cleft condition; in some cases it is completely bifid. Associated with the condition there may be poorly developed testicles, cryptorchidism, and torsion of the penis.

Scrotal Variety.—This is a more complete type of hypospadias than the one just described. There is always a fission of the scrotum which, as a rule, is more marked the further back the orifice is found. The penis is smaller and shorter than normal and seems to be displaced downward. At times it is so covered with skin as to be hidden from view. The prepuce fails to cover the dorsal surface of the glans and takes on more and more the appearance of the prepuce of the clitoris. When the penis is drawn forward the halves of the scrotum have the appearance of labia majora. Extending forward from the meatus is a definite groove lined with pink mucosa. On either side of this groove there are delicate skin folds which give the appearance of labia minora. The testicles are often atrophic and may or may not lie in the halves of the scrotum.

Perineal Variety.—In this form the anterior urethra is entirely lacking and the posterior urethra opens up on the perineum a short distance in front of the anus. The genital region resembles to a high degree that of the female. The scrotum is entirely bifid and resembles the labia majora, especially in those cases where the testicles are ectopic. The penis is small, resembling an hypertrophied clitoris, and is hidden in the folds of the scrotum. Congenital chordee is marked. When the penis is elevated a fold of skin may be seen attaching the ventral surface of the penis to the raphé. On either side of the midline, extending forward from the orifice, are two small divergent folds, the apparent homologues of the labia minora.

Pseudovaginal Variety.—This is the most extreme type of hypospadias; so closely do the organs resemble those of the female that unless a careful examination is made the true sex may be mistaken. The condition is one of pseudohermaphroditism, the "androgynöides irreguliers" type of Pozzi.[183] In addition to the appearance of the genitalia as described under the perineal type, there is a depression in the perineum which resembles the vagina. It is into this depression that the urethra opens. In the case observed by Nové-Josserand the urethral orifice was described as infundibuliform. In other cases the depression may be of considerable depth and capacity, large enough to accomplish coitus. In a case recently observed at the Brady Urological Institute the urethral orifice was found anterior to the pseudovaginal canal, which presented a hymen-like structure at its outlet. This case is of such unusual interest that it will be briefly described:

B. U. I. 12,500, P. O., aged thirty-four, railroad freight agent. Family history is negative for abnormalities. Parents not related. Malformation congenital; patient has never doubted his male sex. Erections began at age of twelve; sexual desire normal; intercourse never attempted because of incurvation of penis. No nocturnal emissions. Masturbation has produced no satisfaction or emissions. No urinary symptoms or difficulties. Examination: The external genitalia are those of the perineal type of hypospadias. The penis is normal in outline, but considerably smaller than normal, measuring in a flaccid state about 2 inches from the

symphysis to the tip of the glans. From the tip of the penis two parallel folds of skin extend backward, while between them is a constricting band which produces a moderate degree of chordee. The penis is pulled downward between the two halves of the bifid scrotum. Both testicles and epididymes are normal in shape, but only about one-half normal size. They lie entirely within the bifid scrotum. There is also a small hydrocele on each side. The urethral orifice is small and is situated in the perineum at a point just behind the scrotoperineal junction. About ½ inch behind this there is a deep depression which admits the point of the index-finger. With some difficulty and causing some hemorrhage the finger is passed to the bottom of the canal at a depth of about 3 inches. A constriction just within the mouth of the pouch closely resembles to the touch a nulliparous hymen. On rectal examination a small atrophic prostate is felt; the left seminal vesicle is definitely made out, but the right is not. On bimanual palpation, one finger in the rectum and the other hand on the lower abdomen, a firm body is felt to the left of the midline, suggesting a uterus or ectopic kidney. (See Figs. 603–605, 942.)

Hypospadias is the most frequent of anomalies of the urethra. Chaussier[176] is reported as finding in 23,293 newborn children 132 malformations of which only 12 were hypospadias, or about 1 in 1800. This figure is much lower than that obtained by other observers. Rennes[184] and Bouisson[174] report the frequency of hypospadias as about 1 in every 300 individuals. In 12,500 admissions to the Brady Urological Institute, 78 were cases of hypospadias, or 1 in every 160. The glandular type is by far the most frequent. Yet because they are usually symptomless, these cases are seldom seen by a physician because of the condition, and are discovered accidentally during the course of a genito-urinary examination.

Etiology.—Of all the various anomalies of the urogenital organs hypospadias offers the simplest of problems from an embryologic point of view. It is now recognized to be a simple arrest of development in the formation of the urethra. The older views, while interesting from an historical point of view, were based upon false conceptions of the development of the urethra and no credence is given to them today. Among these the best known is that of Kaufmann[146] which held that hypospadias is the result of a rupture of the urethra due to a temporary occlusion. Goldman[178] believed that the condition was brought about by an adherence of the amnion to the ventral surface of the developing penis, which resulted in the breaking down of the tissues covering the urethra. Both of these views were strengthened by the cicatricial nature of the under surface of the penis and urethral orifice seen in certain cases of hypospadias. With the work of Tourneux, Born, and Keibel on the development of the urogenital organs the manner in which hypospadias is brought about has been made clear.

It has already been shown how the pars phallica of the urogenital sinus is drawn outward with the growth of the phallus. With it the urogenital membrane, which formerly was situated in the plane of the body wall, becomes tilted downward until it is placed at right angles to the body wall, situated on the ventral surface of the phallus. In embryos of about 12 mm. the urogenital membrane breaks down by a process of resorption and the pars phallica of the urogenital sinus becomes an open groove or gutter on the anal surface of the penis. But it remains as an open gutter for a comparatively short time, for the lips of the groove fuse together to form a canal in much the same manner as the medullary tube becomes the medullary canal. This process takes place from behind forward. Anteriorly an opening is left which is known as the primitive urogenital opening. With the continued lengthening of the penis the groove also grows forward and at the same time keeps closing behind. The terminal portion of the glandular urethra forms by a splitting

of the urethral plate to form a deep cleft-like groove. As this takes place the primitive urogenital opening fuses and the lips of the newly formed cleft fuse in part. The remaining open portion forms the definitive urethral orifice.

Glandular hypospadias, therefore, may be the result of either of two things: (*a*) A failure to reunite of the split urethral plate; (*b*) a failure of the terminal portion of the primitive urogenital opening to close. The first gives rise to the elongated cleft type, the second to the other various degrees of glandular hypospadias. In the latter the urethral plate may split independently, despite the proximity of the urogenital opening, and form a blind depression at the tip of the glans (Fig. 579, A2). In Fig. 579, A3, the terminal portion of the urogenital sinus remains as a groove which is continuous with the open groove formed from the splitting of the urethral plate. In Fig. 579, A4 and 5, the closing defect in the urethral groove is not terminal, and a portion of the groove has closed in front of it to form a blind canal.

The penile varieties of hypospadias may be the result of (*a*) a failure of the urethral groove to extend as far distal as the glans penis; (*b*) a failure of the groove to close in its distal portion; (*c*) of a defective closure at some point along the shaft of the penis with a normal closure beyond this point (Fig. 579, B).

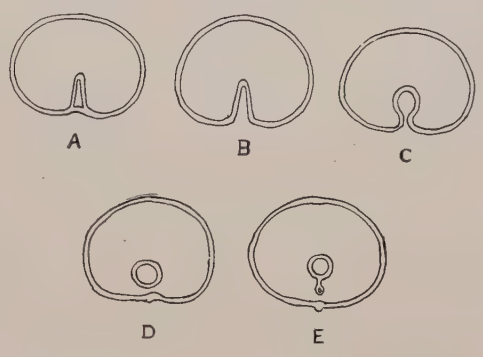


Fig. 580.—Diagram showing the manner of formation of hyposapdias: A, Urogenital membrane stage; B, the urogenital membrane has broken down and the urethral groove or gutter is formed; C, the urethral groove is becoming closed off again by the coalescence of its lips to form the urethral canal. Failure of the lips to unite gives rise to hypospadias; D, normal closure and formation of urethral canal; E, showing the manner of the formation of a cyst or diverticulum of the urethra from defective closure.

In the more extreme grades of hypospadias (penoscrotal, scrotal, perineal, and pseudovaginal) there is a complete failure of the development of the urethral groove beyond the point of the abnormal orifice. This is presumably the result of a faulty relationship between the urogenital membrane and the cloacal tubercle at an early stage. The bifid scrotum is the result of the failure of the scrotal folds to unite in the midline, which again may be termed an arrest of development.

In addition to the "arrests of development" as a cause for hypospadias arises the question as to what extent the defective organs are the result of a tendency toward feminism. Felix[14] states "hypospadias on the free shaft of the penis or in the region of the scrotal sac is not an inhibition, and, therefore, not true hypospadias, but an hermaphroditic phenomenon, a further development of the sinus urogenitalis in the female sense." With the exception of the pseudovaginal type, however, there is nothing in the other types of hypospadias which cannot be explained as the result of an arrested development. The small size of the penis, the position of the urethral orifice, the bifid scrotum, etc., all fall into this category.

One other defect in hypospadias demands an explanation, the congenital chordee so constantly found in the severer grades of the malformation. This was believed by Bouisson[174] to be due to the rudiments of the urethra which adhered to the under surfaces of the corpora cavernosa. Petit, however, showed that there was

an actual retraction of the fibrous sheath of the corpora cavernosa along their ventral surfaces. There seems to be, however, no embryologic reason why this retraction should be an accompaniment to hypospadias.

The *symptoms* of hypospadias vary with the degree of the malformation. The glandular variety, in which the deformity is slight, may exist without symptoms and without the individual's knowledge of the deformity. If the meatus is constricted the urinary stream will be small and projected downward rather than forward. In the penile, penoscrotal, scrotal, perineal and pseudovaginal varieties the stream of urine becomes progressively more difficult to manage and a sitting or squatting posture is necessary in order to prevent soiling of the clothing.

Inasmuch as only the anterior urethra is malformed in hypospadias, both the vesical and membranous sphincter muscles remain unaffected, so that the urinary control is normal.

In the glandular type of hypospadias erections are normal, so that the malformation offers no impediment to coitus. But in the more severe grades, where there is an accompanying chordee, the ventral curvature becomes more accentuated upon erection of the penis and coitus is often difficult or even impossible.

The fertility in cases of hypospadias seems to be a well-established fact despite the fact that these individuals seldom have children. Beck states that in more than 100 cases of hypospadias which he observed not one had children. It must be remembered, however, that most of these cases are seen by the surgeon in childhood or in adolescence, and are afterward lost sight of. Burckhart[175] has cited the case of a father and 4 sons all of whom had hypospadias, as well as 14 adults with hypospadias, of whom 8 had children.

Epispadias is that malformation in which the urethral opening is found dorsal to its normal position. The condition is found in both male and female. The anomaly bears a close relationship to exstrophy of the bladder and is often found associated with this condition.

In the male three types of epispadias are distinguished: glandular or balanitic, penile, and complete.

The *glandular type* is very rare, Katzenstein[180] being able to collect but 5 cases from the literature. It is characterized by the opening of the urethra on the glans or in the coronal sulcus. A groove of varying depth extends from this orifice to the tip of the glans. The glans is flattened dorsoventrally and the prepuce is rudimentary and split on its dorsal surface. The shaft of the penis is short, but otherwise normal.

In the *penile form* the urethral orifice is found on the dorsal surface of the shaft of the penis, being most frequently located near the root. It is generally large and infundibuliform in shape. Extending forward from the meatus is a deep furrow which continues to the tip of the glans. It is lined with a pale red mucous membrane corresponding to the urethral mucosa and in it have been observed lacunæ of Morgagni and glands of Littré. Its borders are firm and erectile, and supposedly contain the remnants of the corpus spongiosum. The penis may show more or less atrophy. The prepuce does not cover the glans and hangs from the ventral surface of the penis as a redundant piece of skin.

In *complete epispadias* the urethra is entirely lacking and the bladder opens directly to the skin. The meatus is large and funnel shaped and occupies the position of the symphysis pubis. The pubes are usually but not invariably ununited.

The penis presents a deformity similar to that of the penile type of epispadias. The sphincter muscle of the bladder is involved in the malformation, is incomplete, and fails to function; incontinence is the result.

From this it will be seen that complete epispadias is closely related to bladder exstrophy, the difference being merely one of degree.

In the female three degrees of epispadias are likewise recognized, namely, clitoric, subsymphyseal, and complete. Varying with the degree of the deformity there exists in these cases a displaced urethral orifice above the clitoris, bifid prepuce, bifid clitoris, widely divergent labia majora and minora, and atrophy of these structures. In the complete form the bladder opens to the outside by an infundibuliform orifice and the vesical sphincter is incomplete as in the male.

Epispadias is of far greater rarity than hypospadias, the ratio being given by Marchal de Calvi[181] as about 1 : 150. Mitchell,[185a] in an examination of 60,000 recruits, did not find a single case. In the Brady Urological Institute an analysis of 12,500 admissions shows but 11 cases of epispadias, of which 1 was in a female.

Like most other urethral anomalies, epispadias has been credited to be the result of a mechanical rupture of the urethra. This view, originally expressed by Bon and Duncan,[87] has been sustained by Kaufmann,[146] who believed that during embryonic life there is a temporary occlusion of the urethra, a distention of the bladder, and finally rupture of the urethra through the dorsum of the penis. This view was accepted by Thiersch, Kocher, and others and seemed to gain confirmation by the finding of more or less cicatricial tissue in the region of the abnormal orifice. Mechanical distention and rupture of the urethra are given by Kaufmann[146] as the cause for bladder exstrophy, hypospadias, accessory urethral canals, urethral fistulæ, urethral diverticula, vesical diverticula, and epispadias. While this theory explains excellently the immediate deformities of the bladder and urethra, it fails completely to clear up those other malformations which are so constantly found in association with them. The theory, therefore, has gradually been discarded, and with a more complete knowledge of the embryology of the urinary organs, other views have taken its place.

Other views no longer maintained are those of Velpeau, who believed that a pathologic lesion of the lower abdominal wall and cloacal tubercle gave rise to exstrophy and epispadias; Guyon,[179] who attributed epispadias to a rotation of the penis so that the urethra came to occupy a position above the corpora cavernosa; Richard and Lejars, who believed that there was a retardation in the fusion of the cavernous bodies which permitted the urethra to pass upward between them; and Torillat,[185] who believed that epispadias was due to a retardation in the development of the cloacal tubercle.

The more modern views are based upon a pure embryologic defect and the same explanation is given for both exstrophy of the bladder and epispadias, the difference being merely one of degree. Since the views of Keibel, Gillis, and Vialleton have already been described under exstrophy of the bladder, only a brief résumé need be given here. These views are based upon a cephalad displacement of the cloacal membrane in an early stage of development before the cloacal tubercle has made its appearance. One embryo (Kroemer-Pfannenstiel) which Keibel studied showed such a forward displacement (Fig. 581, B). The cloacal tubercle developing later arises below the cloacal membrane, so that when the membrane is resorbed the urogenital sinus opens on the dorsum of the phallus rather than on the ven-

trum. If the displacement of the cloacal membrane extends on to the primitive abdominal wall, the result will be exstrophy of the bladder; if the displacement is of lesser degree, epispadias alone results. The diagrams in Fig. 581 show how the malformation may be brought about.

Unlike hypospadias, epispadias is accompanied by defects in the sphincter muscles and by disturbances in the urinary control. In the milder degrees of the malformation there is usually no incontinence, but there is difficulty in directing the stream of urine. In the more severe grades, incontinence, either partial or complete, is the rule, the degree being directly proportional to the severity of

Fig. 581.—Author's conception of the manner in which epispadias is formed. A, Normal development of the urethra and penis. B, The forward displacement of the urogenital membrane has resulted in the growth of the cloacal tubercle below it. With the further growth of the tubercle (penis) the urogenital membrane comes to lie on its dorsal, rather than on its ventral, surface. The membrane is resorbed, and a gutter is formed which may or may not be transformed into a canal.

the malformation. With complete incontinence the patient is always wet from the constant dribbling of urine and the surrounding skin becomes inflamed and excoriated. However, such a patient is infinitely better off than one suffering from exstrophy of the bladder, for the vesical sphincter is present though incomplete, and can, by proper surgical procedures, be made functional.

In addition to the difficulties of micturition, epispadias is responsible for disturbances in the genital function. This is only true for the more severe grades of the malformation; the small size of the penis in some cases, or its broad spade-like shape in others, and its abnormal curvature, make coitus impossible.

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F. TESTICLE

Development.—The reproductive gland develops on the anteromesial surface of the Wolffian body. It first becomes recognizable in embryos of about 5 mm. in length as a thickening of the mesothelium covering this portion of the Wolffian body. As the thickening increases it forms a bulging into the body cavity; grooves develop about its borders and gradually tend to separate it from the Wolffian body (Fig. 582). In this manner the broad base of the reproductive gland is transformed into a narrow stalk, the mesorchium in the male, the mesovarium in the female. The reproductive gland then lies free in the cœlomic cavity except for its stalk-like attachment to the Wolffian body.

Shortly after the anlage of the reproductive gland makes its appearance there develops lateral to it a second vertical fold or ridge which is likewise attached to the mesonephros, and which contains the Wolffian duct. In the upper end of

this ridge there develops a funnel-shaped depression of the mesothelium, the anlage of the Müllerian duct. The broad mouth of this depression opens into the cœlomic cavity; from its apex there grows downward through the substance of the ridge a tubular structure. This, the tubar portion of the Müllerian duct, lies lateral to the Wolffian duct. Slowly the Müllerian duct continues its downward growth until it reaches the pelvis. Here it crosses in front of the Wolffian duct and continues its vertical descent, lying adjacent to its fellow of the opposite

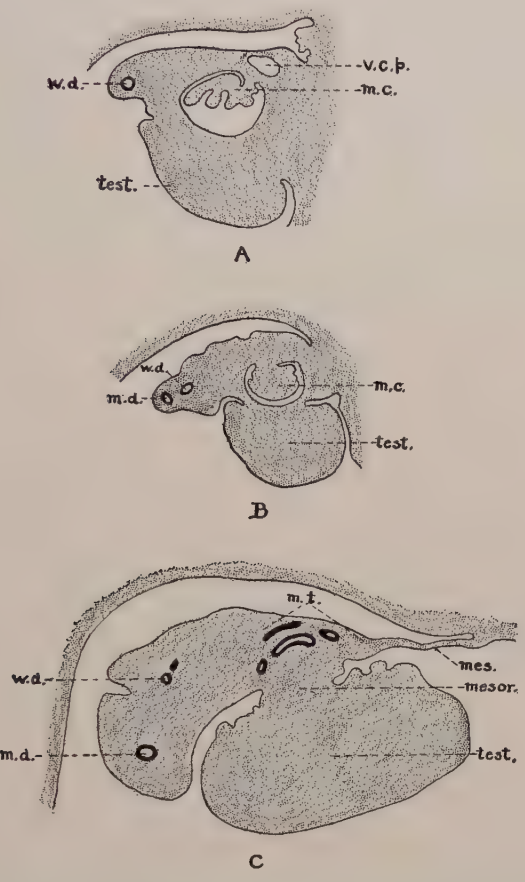

FIG. 582.—Portions of sections showing early development of the reproductive gland. A, Embryo of 12.5 mm.; B, embryo of 19.4 mm.; C, embryo of 50 mm. *Mes.*, mesentery; *mesor.*, mesorchium; *m.t.*, mesonephric tubules; *m.c.*, Malpighian corpuscle; *m.d.*, Müllerian duct; *w.d.*, Wolffian duct; *v.c.p.*, vena cardinalis posterior. After Felix.

side. It finally terminates by joining with the urogenital sinus; this stage is attained in embryos about 45 mm. in length.

While the lower end of the Müllerian duct is making its descent into the pelvis, important changes are taking place at its upper end. Its ostium abdominale, which at the time of its formation was situated in the third to fourth thoracic segments, is gradually drawn downward with the degeneration of the mesonephros. It thus gradually and passively makes a very marked descent, so that by the time its lower end joins the urogenital sinus, the ostium abdominale lies opposite the fourth or fifth lumbar vertebra.

The reproductive gland likewise makes a similar descent and with it the remaining tubules of the mesonephros, but while this descent is in progress the cells of the reproductive gland are undergoing differentiation. In this process the mesothelium plays an important part, for it is in this epithelium that the germ cells lie. The process by which the indifferent reproductive gland is transformed into the adult gland differs in the male and female. In the formation of the testis, medullary cords grow inward from the mesothelium and fill the reproductive gland. These cords contain both the progenitors of the germinal and supporting cells of the testis, and are later transformed into the seminiferous tubules. In the formation of the ovary no medullary cords are formed, but both supporting and germ cells are formed in the mesothelium, and wander into the mesenchyme of the reproductive gland to form the primary follicles.

In each sex the reproductive ducts have a different fate. In the male the Müllerian ducts largely degenerate, whereas the Wolffian duct remains to become the excretory duct of the testis. It will be recalled that this duct is none other than the primary excretory duct, which in turn has served as the excretory duct of the pronephros and mesonephros, and from which the ureter and kidney take their origin.

In the degeneration of the mesonephros a certain number of its tubules remain; these lose their connections from the degenerating mesonephric corpuscles, but retain their connections with the mesonephric duct. As the developing testis increases in size and the mesonephros is undergoing more complete degeneration, these remaining tubules of the mesonephros are brought into closer and closer relationship to the testis. They finally come to occupy a position at the hilum of the testis. They are in a position, therefore, to become connected with the seminiferous tubules of the testis, although for a long period they remain separated from them by the connective tissue of the hilum. The connection is finally effected at the age of puberty by the development of the rete testis. The mesonephric or Wolffian duct in the male forms the vas deferens and the epididymis, and since the seminal vesicle arises as an off-shoot from it, the seminal vesicle and the ejaculatory duct as well. Those mesonephric tubules which escape degeneration remain to form the ductuli efferentia.

In the female the mesonephric duct largely degenerates; rudiments of it remain to form the paroöphoron and the epoöphoron.

The fate of the Müllerian duct will be but briefly alluded to; in the female alone does it attain a high development. It gives rise to the uterine tubes, the uterus, and the vagina. In the male it undergoes extensive degeneration; a small portion of its distal end remains as the utriculus or vagina masculina.

Descent of the Testicle.—The manner in which the testicle migrates from a position high up in the abdominal cavity to its definitive one in the scrotal sac is not fully understood. According to the older writers the gubernaculum was thought to be the chief factor in the descent of the testicle. They believed an actual shortening of the gubernaculum gradually pulled the testicle through the inguinal ring and eventually into the scrotum. More recent views, however, while they admit that the gubernaculum plays a part in the descensus, assert that its rôle is passive rather than active.

According to the views of Soulie[213] and Frankl[191] the descent of the testicle is not a continuous process, but may be divided into stages.

1. *Period of Relative Descent.*—In this period the testicle changes its position,

not by an actual descent, but by the upward growth of the surrounding structures. The period is confined to the second and third months. At this time the gubernaculum is present, but plays no part in the relative descent.

2. *Arrest of Descent.*—In this period, confined to the fourth to fifth months, an equal growth of all parts is described, so that the relative position of the testicle is not changed.

3. *Temporary Ascent* (sixth month).—This is supposedly due to a more rapid lengthening of the gubernaculum than of the surrounding parts; the result is that there is a momentary ascension of the testicle in the abdomen.

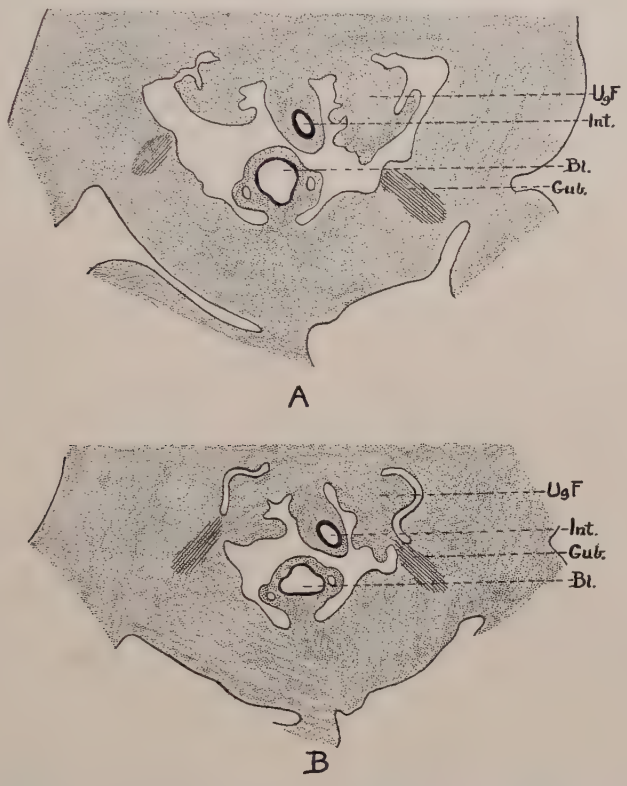

FIG. 583.—Two sections from an embryo of 22.5 mm. showing the beginning of the gubernaculum: *Int.*, Intestine; *Bl.*, bladder; *Gub.*, gubernaculum; *UgF.*, urogenital fold.

4. *Resumption of the Descent* (seventh and eighth months).—Here a cessation of the lengthening of the gubernaculum is described, so that little by little the testicle is drawn through the future inguinal canal and into the wall of the vaginal process which is formed within the scrotum.

5. *Completion of the Migration* (ninth month).—In this period the gubernaculum is supposed to undergo an absolute shortening and draws the testicle to the bottom of the scrotal sac.

According to Felix[14] the testicle does not descend within the abdominal cavity at all and the only migration which the testicle makes is from the abdomen to the scrotum. What appears to be the descent within the abdomen he attributes to the rapid and constant degeneration of the cranial portion of the mesonephros and to the constant additional growth at the caudal ends of the mesonephros and

reproductive gland. He describes the formation of the gubernaculum as a thickening of the mesenchyme which extends from the genital swelling (later to become the scrotal sac) to the testis. This is recognizable in embryos of from 20 to 30 mm. Four portions of the chorda are distinguished, which, from above downward, are as follows: Pars mesorchia, pars mesonephridica, pars intramuscularis, and pars scrotalis (Fig. 584). The gubernaculum, therefore, serves as a connecting ligament between the testis and its adnexa and the scrotum, and plays only a passive rôle in the descent of the testicle.

While the gubernaculum is differentiating there is forming in the lower portion of the abdomen the saccus vaginalis, destined to become the cavity of the scrotum. The formation of this sac has usually been described and pictured as an evagination from the abdominal cavity. Felix[14] has shown, however, that it is actually the lower portion of the abdominal cavity which remains as the saccus, and the constriction which later forms gives to it the appearance of an evagination. When the testicle descends it lies on the posterior wall of the saccus and later evaginates into it. The manner in which the neck of the saccus becomes constricted and eventually cut off from the peritoneal cavity is well known, but the later stages

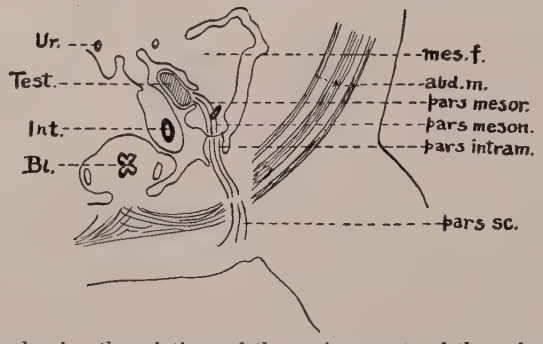

Fig. 584.—Figure showing the relations of the various parts of the gubernaculum. Embryo of 26 mm. *Abd.m.*, Abdominal muscles; *Bl.*, bladder; *Int.*, intestine; *pars mesor.*, pars mesorchia; *pars meson.*, pars mesonephridica; *pars intram.*, pars intramuscularis; *pars sc.*, pars scrotalis gubernaculi; *Ur.*, ureter; *mes.f.*, mesonephros. After Felix.

of the descensus have never been carefully studied; as Felix states, "a considerable hiatus" exists in our knowledge of these stages.

According to Sebileau and Descomps[211] it is incorrect to speak of the descent of the testicle through the inguinal canal, as this structure does not exist as such at the time the testicle passes out of the abdomen. They believe that the cord and saccus vaginalis are responsible for the formation of the inguinal canal, and in support of this view they point out the observations of Bezançon[186] and Tillaux,[215] who have shown that in cases of cryptorchidism the external ring is absent.

Anomalies of Number.—*Anorchidism.*—Absence of the testicle is a rare anomaly and a careful study is necessary in order to distinguish it from cases of arrested or aberrant migration. The anomaly has been divided into three varieties: (1) Those in which the testis alone is absent; (2) those in which only the epididymis and a portion of the vas are absent; (3) those in which both testis and excretory ducts are absent.

Absence of the testis alone, according to Kaufmann[146], Smith,[212] Sebileau and Descomps,[211] and others, is the least frequent variety. The anomaly has only been found as a unilateral condition. Jacobson[198] was able to collect only 5 cases

from the literature. The cases of Thurman,[214] Follin,[190] Legendre,[203] and De Santi[189] showed a small fatty or fibrous mass attached to the epididymis. The question is therefore raised by Sebileau and Descomps as to whether these cases represent a congenital absence of the testis, or are due to a secondary degeneration brought about by some condition such as hereditary syphilis.

In those cases where the testis is present and the excretory duct absent, it has been found that the whole of the epididymis and a portion of the vas are missing. Complete absence of the vas deferens, according to Sebileau and Descomps, has never been observed, for its proximal end, ejaculatory duct, and seminal vesicle are always present.

Absence of both testis and excretory duct is the most common variety of this anomaly. The condition is usually unilateral monorchidism, but cases of true bilateral anorchidism have been reported. The lists of Gruber[194] and Monod and Terrillon[208] include about 50 cases of which the ratio of unilateral to bilateral is about 2 to 1; the left side is more frequently involved than the right in the same proportion. One case is recorded in the 12,500 cases admitted to the Brady Urological Institute.

Anorchidism, like most other anomalies of the genito-urinary organs, frequently coexists with other malformations, among which may be mentioned absence of the kidney and ureter, exstrophy of the bladder, atresia and absence of the urethra, imperforate anus, and malformations of the external genitalia.

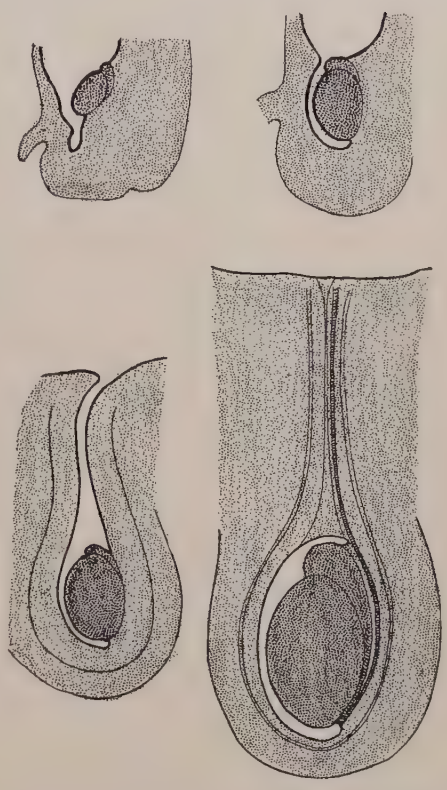

Fig. 585.—Four diagrammatic drawings showing the formation of the saccus vaginalis and the descent of the testicle. After Sebileau and Descomps.

Polyorchidism.—That supernumerary testicles may exist has been clearly established, but there are to be found in the literature numerous case reports which cannot be considered authentic. Small tumors, spermatoceles, hydroceles, etc., may give on palpation the sensation of an accessory testicle, so that direct observation at operation or at autopsy is necessary before the diagnosis of polyorchidism can be made. Cases of this condition have been described within recent years by Vanverts,[216] Defranceschi,[188] Widhalm,[218] Mariotti,[205] Lerat,[204] Marsh,[206] and Lamb.[201] In these cases it is usual to find a complete epididymis and vas deferens for each testicle. Lamb[201] has collected 23 cases from the literature in which the alleged extra testicle possessed an excretory apparatus.

Anomalies of Migration.—Under this term are included those anomalies of development in which there is an imperfect descent of the testicle. The imperfection of migration may manifest itself in either of two ways: (1) The testicle

may be retained at some point along its normal course of descent, arrested migration, cryptorchidism; (2) it may migrate into some abnormal position out of the normal course, aberrant migration or ectopia. A third anomaly of migration has been described under the term "intermittent migration," a case of which has been recorded by Williams,[219] in which the peritoneovaginal canal remained and the testicle, provided with a long freely movable pedicle, moved easily back and forth from the scrotum to the abdomen.

Cryptorchidism.—Strictly speaking the term "cryptorchidism" implies an abdominal ("hidden") testicle. However, the term has come to include all grades of the malformation of normal descensus. Three varieties of cryptorchidism are recognized, the abdominal or supra-inguinal, the inguinal, and the subinguinal. In the abdominal type the testicle is found in the lumbar or iliac regions, lying against the posterior body wall or in the floor of the false pelvis. In the inguinal type the testicle lies within the inguinal canal, while in the subinguinal type it is found at any point between the external inguinal ring and the upper part of the scrotum.

Of all the anomalies of the genital organs cryptorchidism is the most common. The following figures show its frequency in young adults as determined by examination of recruits: Monod and Terrillon,[208] 0.125 per cent.; Marshall,[207] 12 cases in 10,800, or 0.11 per cent.; Hempel,[196] 14,000 cases in 7,000,000, or 0.2 per cent. The condition is usually unilateral; Marshall gives the ratio of unilateral to bilateral cases as 12 to 1. Of 77 cases reported by Odiorne and Simmons,[209] the ratio was 5 to 1. Of 12,500 admissions at the Brady Urological Institute there were 60 cases of cryptorchidism.

In the vast majority of cases cryptorchidism is a truly congenital condition, that is, it is due to defective development. A few cases, however, are apparently due to pathologic lesions. Either trauma or inflammation may be the exciting cause in these cases. The trauma may be due to diapers or to a truss, the pressure producing irritation and adhesions, and the testicle which probably would have descended into the scrotum, becomes permanently fixed within the abdominal cavity or inguinal canal. A number of cases have been cited in which a definite pelvic inflammatory condition, part of a more or less generalized peritonitis, has produced adhesions about the testicle and has thus retained it within the abdomen.

Numerous reasons have been assigned as causes for the lack of descensus of the testicle based entirely upon defective development. Sebileau and Descomps[211] have listed some of these as follows:

1. An abnormal disposition of the mesorchium, hindering the testicle from engaging in the inguinal ring.
2. The paralysis, absence, or vicious insertion of the gubernaculum testis.
3. The congenital narrowness of the external inguinal ring and, inversely, the excessive size of the testicle or its defective presentation.
4. The shortness of the spermatic cord, or adhesions of the spermatic cord, particularly to the peritoneovaginal canal, hindering its regular and progressive lengthening.
5. The rudimentary development of the scrotum.

As Sebileau and Descomps point out, these reasons are not without foundation of fact, and cases have been found in which the anatomic proof seems indisput-

able. Kocher found an abnormal mesorchium; Gerard-Marchant,[192] a narrowness of the external ring, LeGendre,[203] a defective presentation at the internal inguinal ring, Bezançon,[186] a shortness of the spermatic cord, and Jalaguier,[199] a rudimentary development of the scrotum.

Great stress has been laid by numerous writers on the gubernaculum testis, which was thought to shorten and thus draw the testicle into the scrotum. A too long or a displaced gubernaculum would fail to pull the testicle into the scrotum. Godard[193] ascribed to each of the three fasciculi of the gubernaculum as described by Curling a special function. Failure of the external fasciculus to develop normally brought about abdominal cryptorchidism. Absence of the internal fasciculus resulted in the inguinal type of cryptorchidism, while absence of the middle fasciculus produced the aberrant types of migration. This theory is severely condemned by Sebileau and Descomps as being entirely without anatomic foundation.

Sebileau and Descomps state that abdominal cryptorchidism is unquestionably due to an insufficiency or an absence of the gubernaculum. Basing their viewpoint upon Soulie's and Frankl's descriptions of the descent of the testicle, they conclude that the absence of the gubernaculum fails to prevent the testicle from remounting in the abdomen, and it is thus retained as an abdominal organ. They believe that this theory finds confirmation in studies made upon cryptorchidism in other animals.

In order to explain the inguinal type of cryptorchidism they describe the normal descent of the testicle through the abdominal wall as follows: the gubernaculum plays a passive rôle; it does not retract, but it does fail to lengthen. The active cause of the apparent descent through the abdominal wall is due to the manner in which the abdominal muscles develop. The testicle normally changes its relations with the muscles because the latter continue to grow in length and breadth, while in inguinal cryptorchidism the testicle remains firmly fixed by the gubernaculum. Sebileau and Descomps believe that a failure in the normal development of the internal oblique muscle, transverse muscle, and their conjoint tendon gives rise to a retention of the testicle in the upper portion of the inguinal canal; a maldevelopment of the external oblique muscle, to a retention in the lower portion of the canal.

The subinguinal type of cryptorchidism is attributed to any of four causes:

1. The shortness of the spermatic cord.
2. Adhesions of the spermatic cord to the peritoneovaginal canal.
3. The presence of fibers of the internal oblique muscle, which normally form the cremasteric, but which are not elastic enough and thus prevent descent.
4. A rudimentary state of the scrotum.

From this brief résumé it will be seen that there is no uniformity of opinion regarding either the normal descent of the testicle or the causes for incomplete descensus. Unfortunately the embryology of descensus has not been thoroughly studied and until this is done little reliance can be placed upon the theories of the etiology of cryptorchidism. The anatomic findings at operation and at autopsy, while valuable, throw but little light upon the cause for retention, for one cannot distinguish what is cause and what effect. In an imperfectly descended testicle we would not expect to find the spermatic cord of normal length, nor would we expect the relations of the gubernaculum, of the abdominal muscles, of the inguinal rings and canal, and of other associated structures to be normal. While any of

these altered structures might truly be considered sufficient cause for retention of the testicle, on the other hand, they might equally well be considered as effect.

Aberrant Migrations.—Under this term are included those anomalies in which the testicle has migrated to some region out of its normal course of descent. While of far less frequency than cryptorchidism, a number of cases have been observed, and these have been classified according to the anatomic location to which the testicle has migrated. The following classification has been taken from Sebileau and Descomps.[211]

1. Intra-abdominal.—(*a*) *Pelvic,* in which the testicle is found in the true pelvis, inferior to the bladder and under and to the outside of the seminal vesicle. Cases reported by Charpy and Desforges-Meriel.

(*b*) *Deep crural,* in which the testicle, passing through the internal ring, meets with an obstruction, and is shoved out through the femoral ring into the crural region, and as in cases of a femoral hernia, under the cribiform fascia, internal to the femoral vein.

2. Extra-abdominal.—(*a*) *Superficial crural,* in which the testicle leaves the inguinal canal and lodges in the superficial cellular tissue of the femoral triangle.

(*b*) *Cruroscrotal,* in which the testicle leaving the canal slips into the cruroscrotal fold. Cases of Godard, Laborderie and Féré.

(*c*) *Pubopenile,* in which the testicle is found at the root of the penis, in front of the inferior part of the pubis (2 cases by Popow).

(*d*) *Penile.*—A case was described by Poupart in which the testicle lay under the integument of the penis on the right side.

(*e*) *Subcutaneous-abdominal,* in which the testicle, meeting with an obstruction, slips under the skin of the anterior abdominal wall. Leriche, Sorel, and Villeton.

(*f*) *Perineal,* in which the testicle passes downward, and lies in the perineum behind the scrotal-perineal fold. Weinberger[217] has collected 74 cases and Klein[200] 81 cases of this type. Six cases are added by Sebileau and Descomps. One case is found in the records of the Brady Urological Institute.

(*g*) *Transverse ectopia,* in which the testicle passes into the opposite scrotal sac and lies beside its fellow of the opposite side. Halstead[195] reported an interesting case of this type in 1907. Hertzler[197] has recently reviewed the literature on this subject and found 13 cases recorded. The vasa deferentia of the two testicles enter the abdomen through the same inguinal canal. They lie close together and may either remain separate or may fuse; on nearing the prostate they divide, each joining with the seminal vesicle of its own side. Associated with the condition are often found other anomalies, such as congenital inguinal hernia, hypospadias, etc. In the cases of Cornil and Brossard[187] and Hertzler[197] a small infantile uterus was found within the scrotal sac.

Anomalies of Position.—*Inversion of the Testicle.*—Normally the testicle occupies a position within the scrotal sac, its superior pole leaning forward so that it lies further anteriorly than its inferior pole. It is fixed on its vertical axis so that the epididymis lies posteriorly and is suspended in this position by the spermatic cord and by the gubernaculum. Any change in the position of the testicle is known as inversion.

The first classical work on inversion of the testicle was carried out by Royet[210] and LeDentu.[202] These authors described various types of inversion and classified them. LeDentu recognized two fundamental types, the normal inverted and the anteriorly

inverted. Starting with these two types, as shown by Sebileau and Descomps,[211] the other varieties are easily obtained. From the normal position the testicle may begin a forward rotation on its transverse axis and successively become horizontally placed (the rotation of 90 degrees) (Fig. 586, B); or rotated through 180 degrees (Fig. 586, C); or totally inverted through 360 degrees (Fig. 586, D). Similarly, beginning with the anteriorly inverted type, the testicle may rotate on its transverse axis posteriorly, and occupy positions corresponding to the above described ones (Fig. 586, A, B, C, D, lower line).

Cases of inversion of the testicle are not rare, but the diagnosis is not frequently made. The condition is usually unilateral, but may be bilateral. Nothing is known of its etiology. It is considered a congenital anomaly and it has been suggested that an abnormal insertion of the gubernaculum is responsible for the con-

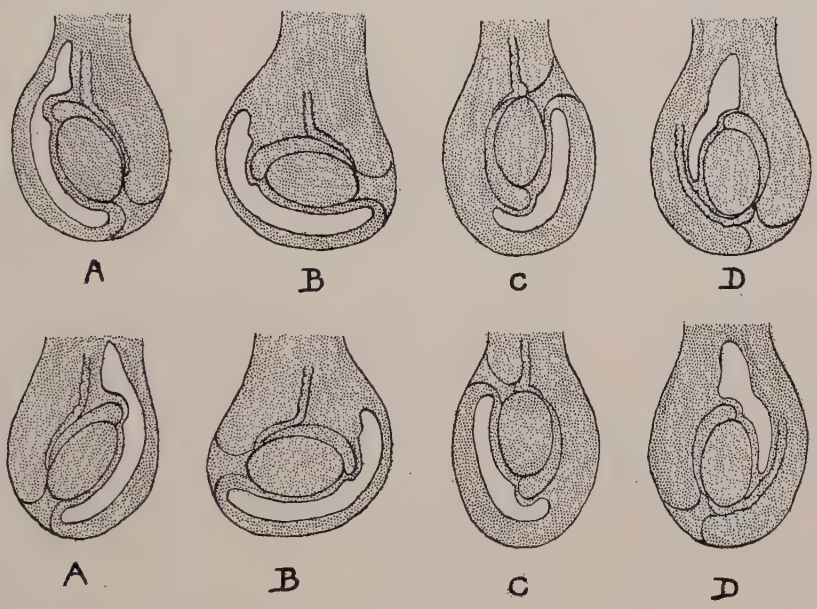

Fig. 586.—Diagrammatic representation of the varieties of inversion of the testicle. Starting with the normal type, A, continued anterior rotation brings about B, horizontal inversion; C, vertical inversion; D, total inversion. Beginning with the anteriorly inverted type (lower line), A, continued posterior rotation produces B, horizontal inversion of the inverted type; C, vertical inversion of the inverted type; D, total inversion of the inverted type. After Sebileau and Descomps.

dition. Inversion of the testicle in no way interferes with the function of the gland and is of clinical importance only when the testis or epididymis becomes affected by some other diseased condition.

Hydrocele.—As stated above, the peritoneovaginal process may remain open so that the cavity of the tunica vaginalis communicates with the abdominal cavity. This is a very rare anomaly. Somewhat more frequently the obliteration of the process is not complete, so that various portions of it remain. If it is the upper end, there is a small process or culdesac within the internal inguinal ring communicating with the abdominal cavity. If it is the lower end, there is a similar culdesac running for a varying distance along the spermatic cord and communicating with the cavity of the tunica vaginalis. If the middle portion persists, there may be one or more cystic cavities lying at any point along the spermatic cord. These

cavities may be flaccid or distended with varying quantities of fluid. The distention may come on at any time during life. This condition is known as *hydrocele of the cord.*

When the tunica vaginalis becomes distended with fluid, the condition is known as *hydrocele of the tunica vaginalis.* It is probable that this has nothing to do with any malformation of the parts. The exact cause is not known, but has been thought by many to be due to some chronic inflammatory process which interferes with the lymphatic drainage of the tunica vaginalis. Hydrocele also occurs in malignant tumors and acute and chronic inflammations of the scrotal contents, as described elsewhere under various headings.

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Pseudohermaphroditism and Hermaphroditism.—Other anomalies of the genital system include those cases in which the genitalia, both internal and external, are developed in such a manner that the sex of the individual is difficult or impossible to determine on external inspection, and also those in which the external organs resemble almost exactly those of the sex opposite to that represented by the gonads themselves. These conditions are spoken of as *pseudohermaphroditism*. A very complete study of this subject with detailed reports of some 1200 cases can be found in the book by Neugebauer.* The usual forms seen by urologists have been described and pictured in the section on Hypospadias. The slight forms found in females cause, as a rule, little functional disturbance. Urination is usually not interfered with, since the position of the urethral orifice in females may vary quite considerably without causing great inconvenience. It is only when the clitoris is very markedly overdeveloped that it interferes with sexual relations. In the more advanced forms the impossibility of determining the real sex of the individual gives rise to extremely complex ethical and legal problems. Since these individuals often have the psychic characteristics as well as the form of external genitalia belonging to the opposite sex, their position in the community is an anomalous one. They may often wish to marry persons who are really of the same sex as themselves, and in such cases the legal rights of the partner-to-be must be fully considered, and the medical man, if consulted, should certainly not advise that any concealment whatever of the known facts be permitted. On the surgical side it sometimes occurs that such individuals desire operations to correct anomalies in their genital organs in the direction of the sex which they consider themselves to be, regardless of their real sex as determined by the nature of their gonads. There is no question that the surgeon should never consent to perform such an operation until he has satisfied himself beyond all doubt of the real sex of the individual. Thus it may happen, as described by Tuffier,† that an individual to all appearances female may desire the removal of an enlarged clitoris and of masses within the labia majora in order to facilitate coitus. On investigation the masses within the labia majora may prove to be normal testes, when the enlarged clitoris is, of course, a penis. Should the surgeon remove these organs he would certainly be guilty of malpractice. In the same way, an individual apparently a hypospadiac male may desire to have the urethra reconstructed to the end of the penis. It is questionable whether this would be justifiable in case the individual should prove to be a female.

The surgeon may often be called upon to examine these patients while small to determine the real sex. It is necessary to exercise great care in this matter and not rely upon a superficial examination. With a knowledge of the tremendously varied abnormalities which may occur it may be necessary to reserve judgment, and in certain cases the only possible way to determine the sex beyond any doubt is to perform a laparotomy and examine the gonads directly. In view of the tremen-

* Die Hermaphroditismus, 1912.

† Tuffier and Lapointe: Revue de Gynecologie, 1911, xvi, 209.

dous importance which the proper determination of sex has for the individual, this procedure is perfectly justifiable when necessary.

True hermaphroditism is that condition in which the gonadal elements of both sexes are present in the same individual. These cases are exceedingly rare. Apparently they are commoner in some of the lower animals than they are in the human race, since a considerable number of cases has been demonstrated in swine. A number of such cases has been reported in the human race, but a careful examination of the literature shows that in the great majority the proof of the condition is not conclusive.

Where true hermaphroditism is present it is classified as follows: (*a*) Bilateral, in which there is one testicle and one ovary on each side of the body, four gonads in all; (*b*) unilateral, in which there is a testicle and ovary on one side and single gonad on the other side, three gonads in all; (*c*) lateral, in which there is a testicle on one side and an ovary on the other; (*d*) a fourth type, in which there are only two gonads, but in which one or both of them is an ovotestis containing both ovarian and testicular elements. There are apparently few or no absolutely authenticated cases of either the bilateral or unilateral forms of hermaphroditism in the human race. An extremely interesting case is reported by Broders* in an individual apparently a male who had monthly bleeding from the urethra. Operation showed both ovarian and testicular tissue on each side. The pathologic description is brief, but indicates that ovary and testis were separate on each side. If so, it is bilateral hermaphroditism. Five other cases of ovotestis in the human being are well authenticated, and there are 2 or 3 cases in which lateral hermaphroditism was apparently present. One can seldom be sure of the exact condition unless the case is examined at autopsy, since when the patient is examined during life, even if operation is performed, one is seldom justified in removing all of the gonadal material present.

In true hermaphroditism the external characteristics may be those of either sex. Apparently in some remarkable cases which have been reported the characteristics of both sexes were present either at the same time or at successive periods. The external and internal genitalia may show any of the anomalies of which these structures are capable. In some of the cases where true hermaphroditism was probable, but not absolutely proved, peculiar circumstances have existed. For example, one individual described in Neugebauer's book who was to all appearances a male, was attracted toward females and capable of coitus. Through the hypospadiac urethra, however, there was a monthly flow of blood. Another individual of indeterminate physical structure was capable of intercourse with either sex. The psychic attitude of this individual in the early part of adult life was that of a female, while later on it changed to that of a male. In these cases the ethical and legal problems are even more complicated than in those of pseudohermaphroditism. It is usually impossible for the surgeon to intervene in these cases in any way which can be justified by the known facts, and the rule mentioned above that he should do nothing until thoroughly satisfied of the real sex of the individual with whom he is dealing will protect him in these cases as well.

In one extraordinary case seen by us, apparently a case of true lateral hermaphroditism, it was considered justifiable to remove the ovarian tissue from the

* Journal of Urology, 1924, xii, 153–158.

individual who was in every way, as far as his somatic structure and psychic make-up were concerned, a male.*

B. U. I. 12,181, aged eighteen years, single. Admitted February 23, 1924, complaining of an undescended left testicle, with malformation of the penis and urethra. His family and past histories are essentially negative. He has had the usual diseases of childhood. At the age of five he had periostitis of the left fibula. He has never had any venereal diseases, but has never attempted intercourse. Aside from the abnormalities of the genitalia described in the physical examination, the patient has had all the normal sex characteristics of the male. The type of bony structure, breast formation, character and tone of voice have all pointed toward a marked preponderating influence of the masculine form of secretion. From early childhood he has liked the forms of play that are so closely associated with boyhood. While at school he played football until he had to stop because of an injury. He is very fond of boxing and baseball. Last winter boxing was his special hobby, and he is said to be one of the best boxers at the school which he attends. At the age of twelve he began to have erections, at which time, because of the nature of its deformity, the penis was always bent downward. About this time he developed an interest in girls and enjoyed dancing with them. As he has grown older he has been "fond of love affairs with girls," and when he has been allowed liberties with them his passions have been excited, and he has had marked erections of the penis. He has never attempted sexual intercourse, although the desire has been marked. So far as can be determined, his reactions toward girls have been those of a normal young man. He says that a year ago he experienced one nocturnal emission, during which he thinks there was a slight discharge of fluid. He has had no similar experience before or since. There is no history of loss of blood from the urethra or of anything suggesting vicarious menstruation. Very early he discovered that the left testicle was undescended, and also that the urine came out from an opening several inches behind the end of the penis. Three weeks ago, following a dance, the patient had pain in the "undescended testicle" in the left groin. He states that following active exercise at the dance he felt a sensation as if the testicle was trying to get out into the scrotum. Since that time he has continued to have pain, particularly on exercising, and he has had to use pressure to push the contents of the canal upward in order to get relief. The pain which the patient experienced from the mass in the left inguinal region (which at operation proved to be female adnexa) was not periodical in nature, nor were there any external forms of hemorrhage accompanying it. He has had no periodic malaise or other disturbance. He desires correction of the malformation of the penis and wants the urethra to be brought out to the end. He has no urinary symptoms and his general health is excellent.

Examination.—February 23, 1924. The patient is a strong, healthy looking young man, about 5 feet, 11 inches in height, weight 144 pounds. Well built, and muscular. Chest that of a strong athletic young man. Usual hair in axillæ and pubic region. Penis well developed. Mammillary region typically masculine. Chest and abdomen negative. In the left inguinal region there is a rounded, movable mass apparently in the inguinal canal. This becomes large and painful on coughing or straining—it can be reduced by gentle pressure. The left external inguinal ring is a little larger than the right and admits the tip of the little finger; there is an impulse on coughing. The right inguinal ring is normal and there is no impulse on coughing.

Genitalia.—There is a marked hypospadias present with considerable congenital chordee. The penis is held downward and markedly curved. The glans touches the upper end of the right testicle. There is no penile urethra, and the urinary meatus is in a cleft of the scrotum about 5 cm. distant from the glans. The orifice of the urethra is fairly large, and the patient passes a good stream. Between the urinary meatus and the glans there is a narrow firm cord which forms a bow to the markedly arched corpora cavernosa. On the under surface of the glans is a small furrow representing the urethra, and a large hooded foreskin is present. The right side of the scrotum is normal in size and appearance. The right testicle is normal in position, but the outlines are difficult to make out owing to the marked irregularity of the structures. It is impossible to make out definitely the limits of either the epididymis or of the testis. There is a small hydrocele present, and the rest of the mass in the scrotum measures about 5 cm. in length, 3 cm. in diameter, is somewhat irregular, slightly nodular or lobulated, generally ovoid in shape.

* Young: Johns Hopkins Hospital Bulletin, 1924.

The veins are normal in size. The vas deferens is not indurated and is apparently normal. The right external ring and groin are normal. The left side of the scrotum is empty, and consists simply of a flabby thin pouch of skin. The testicle, epididymis, veins, and vas are absent.

Rectal.—Anal sphincter normal. The prostate is difficult to outline. It is apparently much smaller than normal, slightly indurated, and slightly adherent. It is thought to be an undeveloped or atrophic prostate. The right seminal vesicle is not palpable. The tissues are very indefinite in that region and much less in amount than normal. On the left side one feels an ovoid elastic mass 2 or 3 inches above the prostate, soft and very indefinite. Low down near the prostate nothing suggesting a vesicle can be made out. There are a few adhesions along the pelvic wall, but nothing suggesting ampullæ can be made out. The triangular ligament is normal. The bulb of the urethra is atrophic or absent. Cowper's glands cannot be felt. The total length of the urethra is very short.

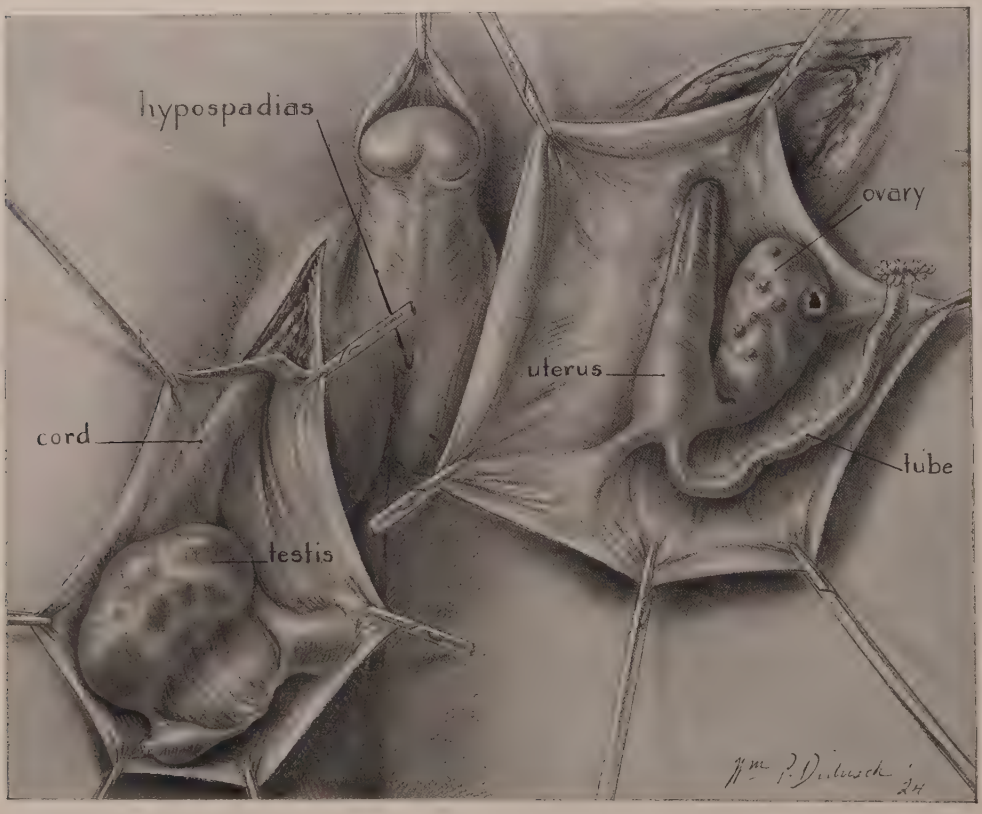

Fig. 587.—Case of true lateral hermaphroditism or mixed sex, associated with hypospadias. The hernia sac in left groin has been opened at operation for supposed undescended testicle, disclosing a normal functioning ovary, with Graafian follicles, one of which has recently ruptured; a normal tube and small uterus, with two ducts leading from cervix through inguinal ring into abdomen. The right scrotal sac was then opened, exposing a testis and epididymis, without vas deferens. B. U. I. 12,181.

Urinalysis.—Normal.

Prostatic secretion could not be obtained by massage.

Operation decided upon. First, to restore the undescended testicle to its proper position in the left side of the scrotum. Second, to correct the congenital chordee by a Heinecke plastic. Third, at subsequent operations to form a penile urethra by a Duplay plastic.

Operation.—February 25, 1924. Dr. Young. Gas, oxygen, and ether.

1. *Operation for Supposed Undescended Testicle of Left Side.*—An incision about 3 inches long was made over the inguinal canal which was opened and a fairly large hernia sac discovered and brought out. This contained an irregular mass, on the inferior surface of which could be felt a mass of veins supposed to be the spermatic cord. The vas could not be felt. When the neck of

the sac had been freed and thoroughly drawn outward, it measured about 2 to 4 cm. in diameter and 10 cm. in length. The sac was then freely opened and the contents turned out. To our amazement it contained not a testicle as expected, but a very definite normal ovary and tube and what looked like an embryonic uterus (Fig. 587).

(Special note by Dr. T. S. Cullen on the contents of the sac of the left inguinal hernia.) "On the inner side there lies the uterus which blends with the peritoneum of the sac and is about 3 cm. in length. At its upper part there is thickening of the peritoneum. The uterus at the fundus is about 2 cm. broad, 1 cm. thick, and tapers down to what may be the cervix, which is about 1 cm. in diameter. From the fundus at the upper side a Fallopian tube passes off. This is 6 inches long and looks perfectly normal. The fimbriæ are unaltered. The ovary measures 5 x 3 x 2 cm. and contains a freshly ruptured corpus luteum. The parovarium looks normal. The forecast is that we shall find the same thing on the right side. The round ligament, instead of starting at the fundus, apparently begins about 2.5 cm. below the tubular insertion and passes down by the side of the cord above described."

2. At this moment the problem seemed to us to be as follows: A normal-looking young man with masculine instincts was found to have a normal tube and functionating ovary in the

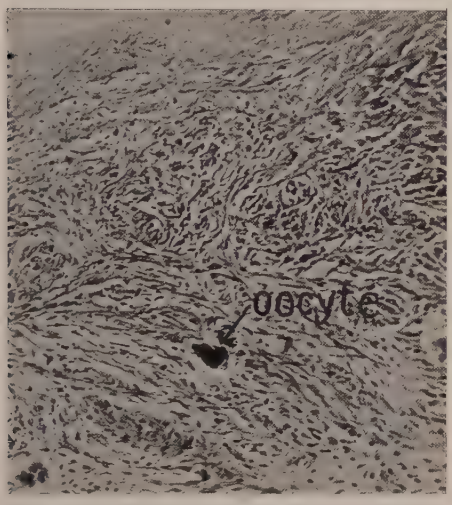

Fig. 588.—Section from the ovary of a case of true lateral hermaphroditism, showing an oöcyte or resting ovum. B. U. I. Path. 4996.

Fig. 589.—Section from the ovary of a case of true lateral hermaphroditism, showing an oöcyte just beginning to undergo the changes which will transform it into a Graafian follicle. B. U. I. Path. 4996.

left groin. What was the character of the scrotal contents on the right side? If these were also undoubtedly female, should they be allowed to remain outside in the scrotum? If a male, should the patient be allowed to continue through life with a functionating ovary and tube in the abdomen on the left side? If the organs of either side should be extirpated, which should they be? It seemed imperative, therefore, to make an incision in the right groin to determine the nature of its contents. An incision was made about 2 inches in length, and the scrotal contents delivered. They were covered with a normal dartos. The veins were large; no vas could be felt or discovered after several incisions and a very careful examination of the cord. There was a small hydrocele present. The tunica vaginalis was opened out and was found to be quite redundant but otherwise normal. Within the sac lay a body larger than the normal testicle, somewhat irregularly lobulated with depressed, indurated, pale areas, the intervening bulging portions being rather softer than normal testicle. The gonad (it was impossible to say whether it was testicle or ovary because it looked typically not like either) measured 5 cm. in length and 2.5 x 3 cm. in diameter. It was invested by a tunica albuginea except posteriorly, where the veins of the cord entered. Externally to this in the position of the epididymis lay a peculiar tubule-like structure which was only loosely attached to the testicle by a "mesentery" from 1 to 2 cm. in length. This structure presented a club-shaped end about 1 cm. in diameter, on the

tip of which was a peculiar red, sessile, soft structure unlike anything we have ever seen. It did not resemble the fimbriated end of a tube. The rest of the structure beyond the club-shaped end tapered down to a small tube, 3 or 4 mm. in diameter, which extended for a distance of about 4 cm., where it ended in a peculiar body which lay beneath the tunica vaginalis. The outlines of this body were indefinite. In consistence it was fairly firm (it was subsequently removed for examination). Running upward and backward from this body two very small fibrous cords were seen beneath the tunica vaginalis. Careful examination showed that these were not tubular (they contained no lumen). As these cords passed upward they seemed to coalesce where they joined the spermatic vessels in the cord, but from that point they disappeared and nothing suggesting a vas deferens could be found on very careful examination. Dr. Cullen gave his opinion as follows: "The large body is, I believe, an ovary. Behind it is a tube, and the peculiar body on the end of this is the fimbriated end. On the other end of the tube the peculiar subserous body is the undeveloped other half of the uterus."

The supposed ovary was, however, entirely unlike the normal and nothing suggesting corpora lutea could be seen (such as were present on the opposite side).

As the question was one of great importance, it seemed wise to excise a fairly large section of the upper end of the gonad in order to determine its character. This was done. A piece about

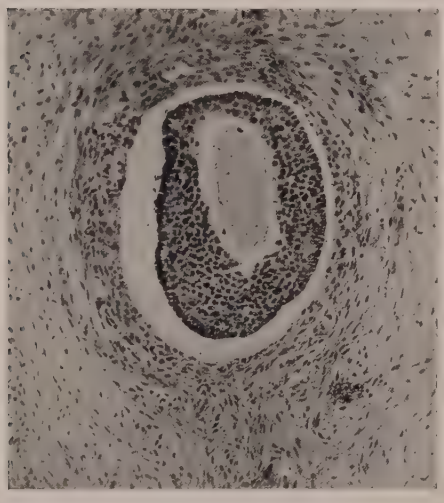

Fig. 590.—Section from the ovary of a case of true lateral hermaphroditism, showing an early Graafian follicle. B. U. I. Path. 4996.

Fig. 591.—Section from ovary of a case of true lateral hermaphroditism, showing a moderately developed Graafian follicle. B. U. I. Path. 4996.

2 cm. in diameter and almost 1 cm. thick being removed. Frozen sections were made and examined by Dr. TeLinde, assistant resident gynecologist, who reported that it was certainly not an ovary. It contained tubules, epithelial and interstitial cells which Dr. Davis thought were undoubtedly testicular. It was then decided to restore the scrotal contents on the right side, but before so doing the peculiar body, supposed by some to be an infantile uterus, was excised from its location in the tunica vaginalis, on the right side. The testicular wound was then closed with catgut, the tunica vaginalis turned inside out and sutured behind the testicle (as in the operation for hydrocele), and the scrotal contents were returned. The subcutaneous fascia was closed with catgut and the skin with metal clips.

It had been determined to preserve the masculine contents of the right scrotal sac. It seemed obvious, therefore, that the only thing left was to remove the female contents of the left hernia sac. This was accordingly done. The hernia was removed completely and brought with it the ovary, tube and uterus, the point of division being about 2 cm. distant from the cervix. In making this division a large group of veins was ligated and divided. Two small muscle-like structures and one tube, exactly the size and consistence of the vas deferens were divided. This tube and the two cords lay beneath the peritoneum, and the general direction was toward the pelvis by the side of the bladder.

The tissue removed was carefully dissected and numerous sections made from all parts of it. The dissection showed that the ovary, Fallopian tube, fimbriated extremity, mesovarium, and mesosalpinx were normal in appearance and in their mutual relationship. The uterus was,

FIG. 592.—Section from the ovary of a case of true lateral hermaphroditism, showing a portion of a recently ruptured ripe follicle. The theca follicularis and the lutein cells are well shown. B. U. I. Path. 4996.

FIG. 593.—Section from the ovary of a case of true lateral hermaphroditism, showing a perfectly typical corpus fibrosum. B. U. I. Path. 4996.

of course, very small, but its consistence was that of a normal uterus. On dissecting it down toward that part of the specimen which entered the inguinal ring it became smaller and smaller and finally ended abruptly, the end being rounded off. Alongside this end of the uterus and at a little distance from it lay a cylindrical tube-like structure which had been cut off at a point

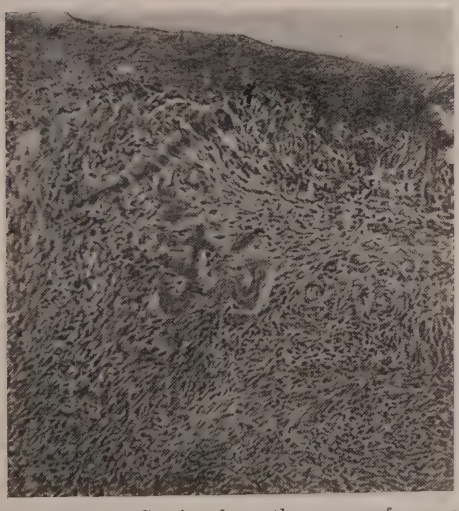

FIG. 594.—Section from the ovary of a case of true lateral hermaphroditism, showing a small corpus fibrosum. B. U. I. Path. 4996.

FIG. 595.—Section from the Fallopian tube of a case of true lateral hermaphroditism. This section is typical in every respect. B. U. I. Path. 4996.

where it entered the external ring. This structure when followed in an outward direction diminished in size and finally ended abruptly, the end being somewhat pointed. It turned out to resemble microscopically the vas deferens and lay alongside the blind end of the uterus, very distinctly and completely separate therefrom.

Microscopic sections (B. U. I. Path. 4996) were made from these structures and photomicrographs of these sections are shown in the accompanying figures. It will be seen that all

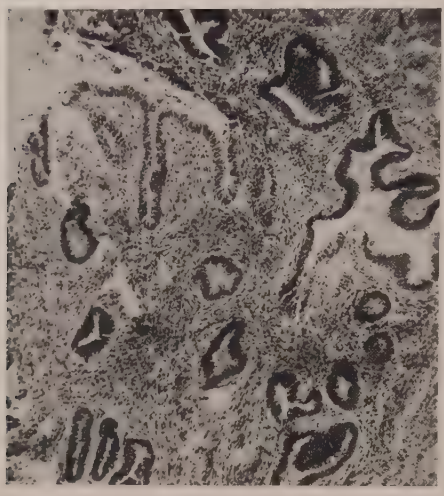

Fig. 596.—Section from the uterus of a case of true lateral hermaphroditism, showing typical glands embedded in smooth muscle. B. U. I. Path. 4996.

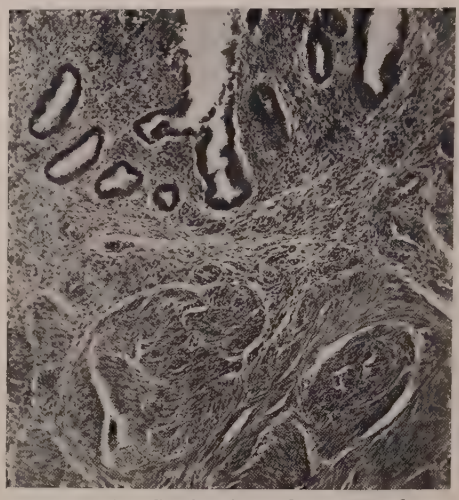

Fig. 597.—Section from the uterus of a case of true lateral hermaphroditism, showing uterine glands and smooth muscle arranged in characteristic bundles. B. U. I. Path. 4996.

of the female elements are very close to normal in appearance. Oöcytes and ova are seen at all stages of development surrounded by perfectly normal Graafian follicles. One follicle has just

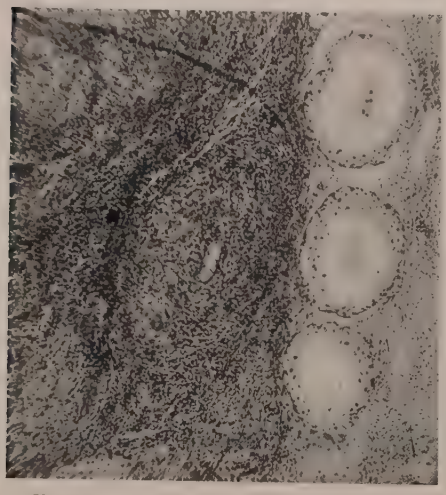

Fig. 598.—Section from the testis of a case of true lateral hermaphroditism, showing a number of typical but inactive seminiferous tubules surrounded by masses of cells which are probably hypertrophied interstitial cells. B. U. I. Path. 4996.

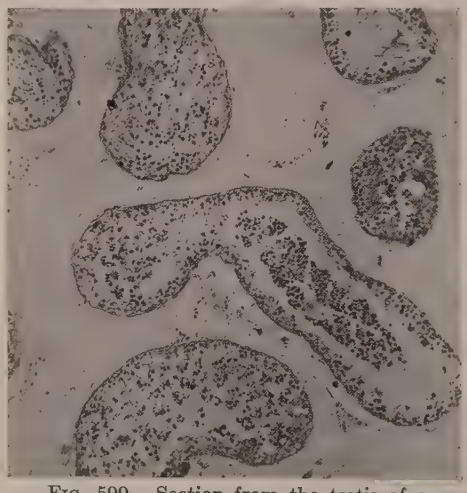

Fig. 599.—Section from the testis of a case of true lateral hermaphroditism, showing typical but inactive seminiferous tubules in a portion of the testicle where the hypertrophied interstitial cells are not present. Note that the tubules are very loosely held together as in a normal testis. The granular material in the tubules is composed of cellular débris and no definite spermatozoa can be identified under the high power. B. U. I. Path. 4996.

ruptured and this collapsed space is filled with blood and lined by typical lutein cells. The glandular system of the small uterus is much simpler than normal, but otherwise typical. On the opposite side, however, the structure of the testis is markedly abnormal. While there is no ques-

tion that it is a testis, yet the tubules nowhere show any definite spermatogenesis. The cells lining them are not degenerated, however. In some areas the tubules lie close together separated only by the smallest amount of stroma, while in other places they are embedded in a tre-

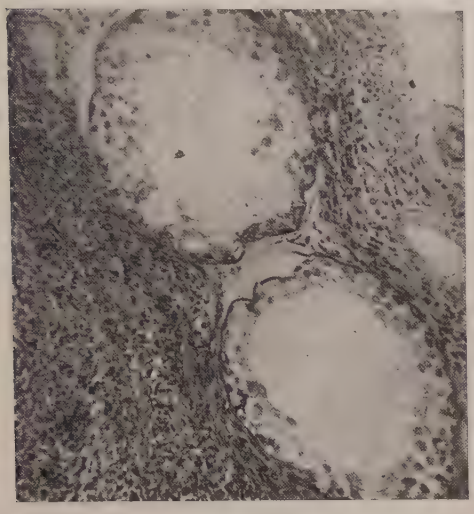

FIG. 600.—Section from a testis of a case of true lateral hermaphroditism, showing in higher magnification the seminiferous tubules. While inactive with no sign of spermatogenesis they are typical and resemble exactly those found ordinarily in cryptorchid testes. B. U. I. Path. 4996.

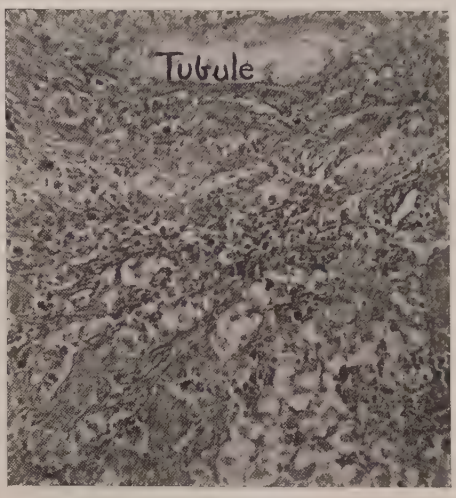

FIG. 601.—Section from the testis of a case of true lateral hermaphroditism, showing one atrophic seminiferous tubule surrounded by a mass of cells which are probably hyperplastic interstitial cells. Note the swollen, hydropic condition of these cells. B. U. I. Path. 4996.

mendous mass of cells. These cells have rounded vesicular nuclei, some have a small or moderate amount of cytoplasm which stains well with eosin, whereas in a great many others the cytoplasm is tremendously hydropic and appears as a wide almost entirely clear area surrounding the nucleus. The obvious assumption is that these cells represent an enormous hypertrophy of

FIG. 602.—Section from the vas deferens of a case of true lateral hermaphroditism. This section is typical in every respect. B. U. I. Path. 4996.

the interstitial gland, although they are more abundant than we have ever seen in a cryptorchid testicle.

Judging from the assumptions which are usually made concerning the endocrine functions of the gonads, it would appear that these hypertrophied interstitial cells have the ascendency com-

pletely as far as the endocrine influence is concerned, because, although the individual was possessed of a functioning, apparently normal ovary, his external form and psychic make-up were very definitely and indisputably those of a male.

The following abstracts are also given of other interesting cases which must be classed as pseudohermaphrodites:

B. U. I. 12,500, P. O., age thirty-four. Family history negative for abnormalities. Parents not related. The malformation has always been present, but the patient has never doubted his male sex. Erections began at the age of twelve. Sexual desire has been normal, although intercourse has been impossible and apparently not attempted because of the curvature of the penis, which is accentuated on erection. The general health has been good, and the patient works successfully as a railroad freight agent, although he is not of a very sturdy build. He comes to the clinic now for correction of his deformity because he desires to marry.

FIG. 603.—Perineal hypospadias with pseudovagina. Condition with patient standing; penis completely obscured behind bifid scrotum. B. U. I. 12,500.

Examination.—Height 5 feet, 5½ inches, weight 128 pounds. Patient states that he has always considered himself entirely male in every respect with normal feelings toward the female sex. He has never had or attempted intercourse. Sexual excitement is followed by erection. There is no history of ever having had nocturnal emissions and patient further states that on a few occasions when he has stimulated his genitalia, no emission has occurred and no feeling of satisfaction has been experienced. The urinary function is apparently normal in every respect; does not get up at night to void. No difficulty or hesitancy.

Rectum lies posterior and slightly to the right. Easily admits finger and apparently entirely negative. In region normally occupied by prostate is a body a little smaller than normal prostate but about shape of prostate and also normal in consistence. On the right side the seminal vesicle cannot be definitely made out but apparently some induration and adhesions are present in that region. On the left side seminal vesicle can be definitely made out, apparently elastic and only slightly adherent. Between vesicles no vasa are definitely palpable. To the left and anterior to the rectum there is an orifice which admits the point of index-finger, and with difficulty the first and second joints pass, some pressure required and bleeding caused. Finger

passes for distance of 3 inches until limit of pouch is reached. This pouch is apparently lined with smooth mucous membrane and has fairly thick walls running upward and backward around to left lateral wall of the rectum. In the extremity the finger in the pouch is slightly posterior to the finger in the rectum and lies to the left. Orifice of urethra immediately in front of pouch (Figs. 603–605, 942.).

To the left of the rectum is a puckered and dark area in the skin which looks like a scar. At the lower median angle of this scar are two small orifices which look like the orifices of a tiny fistula. On probing, however, these little orifices are found to be blind and not connected with any sinus tract. In the left side of the orifice anterior to the rectum there is a bulging mass of mucosa about 1 cm. in diameter having superficial appearance of hemorrhoid. At the left anterior margin of this orifice, that is, just within mucocutaneous border, is a small rounded object just beneath the mucosa, which is rather pyramidal in shape. The point projects posteromedially and is apparently firmly attached to the ischial tuberosity, itself of cartilaginous consistence. Just inside this protuberance there is a constriction in the orifice which is very thin and resembles to the touch a nulliparous hymen. With finger deeper in this orifice one can feel

Fig. 604.—Hypospadias, pseudohermaphrodite with vagina admitting finger 2½ inches. Small retracted penis almost obscured between folds of cleft scrotum. Testes normal. B. U. I. 12,500.

the upper aspect of the cartilaginous projection in close relation with the ischial tuberosity. On bimanual palpation with one finger in the orifice and other on the lower abdomen, no definite body is made out medially or to either side, although there is present a trifle of thickening in the right side of the pelvis. With finger in rectum high up there is felt a rounded movable body to the left of the median line. On bimanual palpation the upper margin of this body is made out three fingerbreadths below the umbilicus and three fingerbreadths to left of median line. This may be firm feces in the sigmoid, but it does not feel that way, being quite elastic like an organ composed of smooth muscle. Quite freely movable. Nothing corresponding to this on right side of pelvis. Below this movable body very little can be made out anteriorly until one comes within 1½ inches of the anal opening where a small, firm, round body can be felt anteriorly, very much resembling atrophic prostate in shape, size, and consistence. Further examination shows that this is anterior to the abnormal orifice and is felt through its walls. Anterior to the abnormal orifice the organs present a picture typical of perineal hypospadias. The urethral orifice is small and situated in the midline about ½ cm. in front of abnormal canal. From it to the tip of the penis run two parallel folds and beneath them a constricting band which causes

penis to have a fairly marked degree of congenital chordee. Penis itself is normal in outline, considerably smaller than normal, measures in flaccid condition about 2 inches in length from symphysis to the tip. It is pulled far down between halves of bifid scrotum. Scrotum is well developed. Skin has appearance of normal scrotal skin. Left testis is surrounded by small soft hydrocele. It is normal in consistence and is smooth but scarcely half normal size. Globus major, body, and globus minor can be palpated readily. Globus minor extends nearly 3 inches below lower pole of testis. Vas deferens can be made out running upward to the spermatic cord. It seems to be slightly smaller than normal. The inguinal canal admits tip of finger readily but no impulse felt on coughing. Right testis also has small soft hydrocele. It is the same in size and consistence as the left. Epididymis here can be palpated but globus minor does not extend below testis as on left. On both sides epididymis apparently normal in shape and consistence.

FIG. 605.—Hypospadias; perineal opening of urinary meatus, immediately behind which is a pseudovagina admitting finger 2½ inches. Scrotum bifid. Penis bound down by congenital fibrous tissue between testes. B. U. I. 12,500.

On this side also vas is palpated. Cord passes through apparently normal ring which gives no impulse on coughing. The mass in the abdomen, if not feces, may be a uterus or an ectopic kidney.

B. U. I. 4422, R. S., admitted to the Brady Clinic of The Johns Hopkins Hospital on June 8, 1915, for hypospadias and undescended testicles. He was ten years old in July, 1915.

The family history relates that one brother died at birth, and one at seven months of age. One younger sister is living and is normal. Both parents are well; they are first cousins. The father has a slight hypospadias with the meatus about ½ inch below the apex of the glans.

Until two years of age the patient suffered from "marasmus," but otherwise has been entirely well and strong, and has had none of the exanthemata. His mentality is considered good, and he is now in the third grade, although attendance at school began only two years ago. His habits and activities are those of a normal boy; he spurns girlish pursuits, and much prefers such

games as football. The pubic and axillary hair has been present for four years. The voice has always been "coarse" and the hands and feet "stubby." Since birth the urethra has opened at the base of the penis and the testes have not descended. There is an entire absence of any history of abdominal pain or crises suggestive of retained menses, and there has never been any bleeding from the penis. Libido has not appeared as yet.

Physical examination finds the general bodily condition and color excellent. The musculature is well developed. The head is rather large, with prominent frontal regions, and the shoulders, though broad, are markedly stooping. The forehead is of moderate height; the face is broad; the lips are thick; the nose is flat. The hair, dark brown in color, is rather coarse, and is lacking over each lateral frontal region. The eyebrows are more sparse in their outer portions than toward the root of the nose. The eyes, ears, and mouth are normal. The ears show no stigmata and upper central incisors are no broader than the other incisor teeth. The palate is moderately high. There is a considerable amount of fine hair on the upper lip; the axillary and pubic hair is abundant, the latter showing the female type of distribution. The hands are broad and short, the finger-nails have been bitten. The skin over the body is somewhat harsh. There are no abnormal deposits of fat. On examination, the heart, lungs, and abdomen are entirely normal. The breasts are undeveloped and of the male type. Very careful palpation shows no sign of any abnormal abdominal mass. There is no unnatural pigmentation of the skin. The growth of hair below the knee on each leg is in marked excess.

On examination of the genitalia, the phallus is found to be represented by an organ 5 cm. long, curved markedly toward its ventral surface. There is a well-developed prepuce drawn into folds on the dorsum, but not uniting completely in the midline on the ventral side. This covers the glans, which is well developed except for the meatus, which is replaced by a ventral groove. At the base of this structure, between it and the slightly prominent mons, the skin rises in a fold, and encircling the phallus, extends downward on either side to form the bifid scrotum or labia majora. No testes or spermatic cords are to be felt anywhere. When the glans is drawn upward, the opening of the urethra is seen at a point corresponding to the penoscrotal junction. From this to the tip of the glans the middle line shows a longitudinal gutter covered by striæ of mucosa. The perineum from meatus to anus is smooth and without trace of depression. There is nothing to suggest labia minora. An abundance of hair is present, and the skin of the perineal region and adjacent thighs is harsh and coarse.

There is a definite lack of equilibrium on the part of the superficial vasomotor system. The hands are cold, clammy, and often of dusky hue; the skin of the body shows mottling on cooling, and the patient blushes very readily. All the outer reflexes are lively, but there is no cremasteric reflex.

Rectal examination shows an apparent absence of the prostate, although in the region above this area there is felt a small mass which is about 2 cm. long and 1 cm. broad, not tender, and only slightly movable.

Radiographs of the head, chest, abdomen, pelvis, and hands are entirely normal. The urine is normal and the ingestion of 150 grams of dextrose caused no glycosuria. The phenolsulphonephthalein output was 60 per cent. during the first hour. The Wassermann test was negative.

Blood-pressure: Systolic, 115; diastolic, 90.

An operation was performed on June 14, 1915, to better the hypospadiac condition, and to search for the supposed testicles and bring them down. No trace of the spermatic cord could be found in the inguinal canal. On entering the abdomen an infantile uterus was discovered with tubes and ovaries of normal appearance. An ovary, with an adjoining portion of its tube, was excised for histologic examination.

The specimen consists of an ovary 2.5 x 1.3 x 1.7 cm., together with about 5 cm. of tube, bearing normal fimbriæ. Running from one side of the ovary is a layer of very thin tissue, apparently a bit of the broad ligament containing on one surface a small, very flabby mass in the position of the parovarium. The surface of the ovary is smooth, and on section it is seen to contain numerous areas varying in size, presumably follicles. The larger of these contain bloody fluid, the smaller watery fluid.

Microscopic Examination.—Sections of the ovary show a typical normal structure. Graafian follicles contain ova in various stages of development. No corpora lutea are seen, although there is in one area a splendidly preserved corpus fibrosum. A careful search failed to show any abnormal elements.

The Fallopian tube shows the usual papillary-like foldings of mucosa with normal epithelium.

The parovarium shows numerous tubules, thin-walled, and having a single layer of epithelium.

B. U. I. 12,513, C. J., age eighteen. Family history negative. Parents not related. A deformity of the genitalia was noted at birth, but the attending physician declared that the baby was a girl, with hypertrophied clitoris. The patient was, therefore, reared as a girl, and nothing was noted until the age of eleven, when the labia became much larger, due no doubt to the descent of the testes. At the age of thirteen sexual desire was first experienced and, although not frequent or unduly strong, has always been directed toward females. It is accompanied by erection. At the age of seventeen, one year before admission, nocturnal emissions commenced, and have occurred about once in three or four weeks. Masturbation has been practised a few times, with orgasm and ejaculation, which occurs through the urinary orifice. Micturition is entirely normal. No menstruation or monthly symptoms of any kind.

The patient is intelligent and apparently in perfect health. He graduated from high school recently. He has noticed his sexual peculiarity, but took no steps until a week before admission, when upon coming east, he voluntarily adopted male clothing and assumed the name of "Charles."

Examination.—The patient is 5 feet, 8 inches tall, weight 130 pounds. He has not shaved this morning and a very slight beard is on his face in normal location. Shoulders are well formed. Waist about normal for a boy eighteen years of age, well developed. Pubic hair is masculine, although the patient has shaved off the upper part to simulate the female type. Legs are slightly bowed, knees do not come together. Muscles of thigh steady. Patients wears No. $6\frac{1}{2}$ shoe. Feet normal in appearance, very high arch.

Genitalia.—Scrotum is bifid; two halves, however, are of about normal size and appearance, the left side being much larger than the right. In each side there is a testicle, normal in size, shape, and consistence. The epididymes are somewhat smaller than normal, otherwise negative. Vasa are found on each side, that on the right being smaller than that on the left. The right epididymis is attached more loosely to the testicle than the left. On the left above the testicle is a hernia which is reducible through an enlarged ring. It is apparently congenital as the testis can be reduced with it. In the cleft between the halves of the scrotum is a penis which is typical of extreme hypospadias—short and curved. Glans is $\frac{1}{2}$ inch in diameter, foreskin redundant. Usual furrow is seen on the ventral surface and extends backward into a pouch in the perineum. Posteriorly this pouch is bounded by a very thin membranous septum, the edge of which is $\frac{1}{2}$ inch in front of the anus. The pouch is lined with red mucous membrane, is $4\frac{1}{2}$ cm. deep, and large enough to admit the finger easily. It is surrounded by a muscular ring. The urethra enters the anterior surface of this pouch about 2 cm. within its orifice. Above this point the urethra can be palpated anteriorly, but there is nothing to suggest prostate or seminal vesicles. Above the pouch ends blindly and there is no suggestion of a cervix. This case is shown in Fig. 941.

This is evidently an extreme degree of masculine pseudohermaphroditism with a definite vagina, into which the urethra opens. That part of the vagina below the urethra could, therefore, be a portion of the urogenital sinus and that part above the urethra would represent the lower part of the Müllerian ducts. The testes, epididymes, and vasa are so distinct, however, that there can be no question as to the real sex of this individual.

B. U. I. 9222, L. J. T., age twenty. In this patient's case, he was thought at the time of birth to be a girl, and he was brought up as a female. At the time of puberty, he was attending a girl's boarding school. The exact nature of his sexual life is not known, but he stated that he had always been in demand as a roommate. At this time erections commenced and the voice changed, so that the question of sex was raised, and he assumed male clothing. Sexual desire has always been directed toward females. Erections are good, and ejaculations occur normally through the urinary meatus. Sexual intercourse is possible, but imperfect.

Examination.—Patient presents a masculine appearance, has sufficient hair on the face to require shaving. The body contours and distribution of hair are masculine. Scrotum is bifid, the halves are rather small. On each side is a testis, somewhat smaller than normal but of normal shape and consistence. Each has a small but definite epididymis and vas. The testes are high so that when in the standing position they lie in the upper part of the scrotum, but when patient is lying down they are found just below the external ring. Penis lies between the halves of the scrotum and is typical of extreme hypospadias, being about 3 cm. in length and much curved. Usual urethral furrow is on the undersurface running back to the urethral orifice which is in the midline of the perineum 2 inches in front of the anus. There is no pouch or pseudovagina. The mucous membrane of the urethra is redundant and pouting, having the appear-

ance of a urethral caruncle. On rectal examination the perineal tissues are much thinner than normal. Urethra and base of bladder can be palpated but there is nothing to suggest prostate, vesicles, or ampullæ. After massage in this region some material containing lecithin bodies was obtained, but no spermatozoa are seen.

This is evidently a case of masculine pseudohermaphroditism, the testes being sufficiently characteristic that there is no question of the patient's real sex.

Another interesting case of pseudohermaphroditism, beautifully illustrated, is given by Cullen.*

Endocrine disturbances involving genital hypoplasia or hypofunction are not infrequently seen in urological clinics. They do not properly constitute a urological problem. It may be justifiable in certain cases with cryptorchidism to attempt to bring down the testes, but little is to be expected from this procedure. Testicular transplantation likewise has usually been barren of results.

These disturbances may take various forms of which perhaps the most common is dystrophia adiposogenitalis, or Fröhlich's disease. The two following cases are quite typical, and may serve as a description:

B. U. I. 8900, C. M. T., age thirty-six, single. This patient complained of frequent and painful urination, and pain in the back. He has lived on a farm all his life, and has never been able to do much work. The present symptoms have been present about six years, otherwise the health has been good. He has occasional erections.

Examination.—The patient is of average height and weighs 200 pounds. He has weighed 215 pounds. The general contour of the body is definitely eunuchoid, with protuberant abdomen, large breasts, and almost complete absence of body and facial hair. The voice is high. The genitalia, including penis, testes, epididymes and seminal vesicles, are all present and normal in contour, but extremely small and undeveloped. *x*-Ray examination shows a normal sella turcica, and the eye-grounds and visual fields are normal. Cystoscopy showed a very small bladder, without obstruction, and the capacity was increased by hydraulic distention with improvement of symptoms.

B. U. I. 8956, I. W., age fifteen. The complaint was of undescended testes. The history was negative except that the patient has always been rather inactive, preferring to read. The weight has been as great as 160 pounds, at the time of admission it was 155 pounds. One previous bilateral operation was unsuccessful in bringing the testes into the scrotum.

Examination shows an obese boy, with femine contours, well-developed breasts, prominent abdomen, transverse pubescence, and absence of facial hair. The penis is normal, but only about 4 cm. long. Scrotal skin is present, but there is no sac formation, and the testes are not palpated here or in the inguinal canals, though there is a small irregular mass under each inguinal scar that may represent the remnants of the testes. The prostate is extremely small, and can scarcely be made out, while the seminal vesicles are not felt. No operation was performed.

In another similar case we implanted human testicular tissue, which healed in place perfectly. The patient declared himself improved, but no objective change could be made out.

G. UTRICLE, SEMINAL VESCLES, AND VASA DEFERENTIA

The commonest anomalies of the prostatic utricle are those associated with the various degrees of pseudohermaphroditism. The developmental changes in the Müllerian duct have been described in the section on Anomalies of the Testis. In masculine pseudohermaphrodites the normal degeneration of the Müllerian ducts may not occur. There may even be the formation of a complete uterus and Fallopian tubes, with an opening into the urethra at the usual location of the

* Surgery, Gynecology, and Obstetrics, 1911, xiii, 449–453.

verumontanum, or, if there is a perineal urethral hypospadias, the uterus may open into a pseudovagina. The tubes may be abdominal, or may be drawn into the inguinal canals by the descent of the testes. In other cases the uterus is bi-

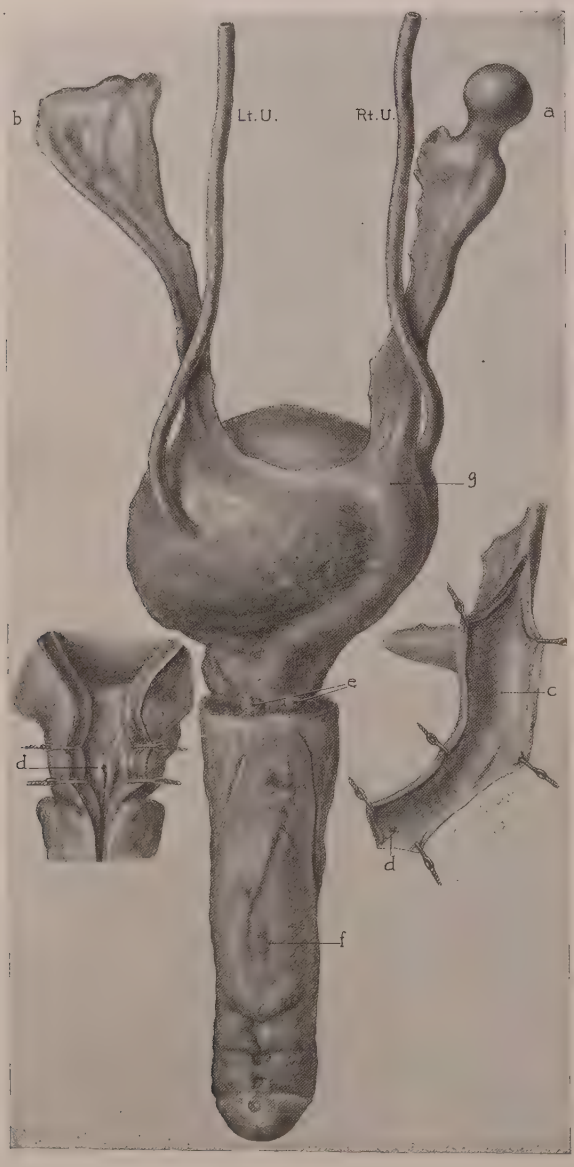

Fig. 606.—Hypospadias with undescended testes. Posterior view of intact specimen removed at autopsy: *a*, Testis and epididymis, right; *b*, denticulated anomalous fold of peritoneum with a cord containing no lumen; left testis, epididymis, and vas absent; *c*, interior view of enlarged utricle opened longitudinally; *d*, opening of utricle into floor of membranous urethra; *e*, Cowper's glands; *f*, ventral aspect of penis after operation for hypospadias; *g*, enlarged utricle which formed a sac 3 inches long on posterior surface of bladder and prostate. B. U. I. 7069.

cornate, in which event a uterine cornu may lie in the inguinal canal. Again, the Müllerian ducts may persist without the formation of an actual uterus. Thus there may be seen anomalous tube-like structures running from the verumontanum

up on the posterior surface of the bladder, either single, double, or Y-shaped, giving a bicornate effect. If of sufficient length, the tube-like structure may extend into the inguinal canal, and even form part of the spermatic cord and be attached in the region of the epididymis. Such a structure when found in the spermatic cord is known as a ductus aberrans. In such cases careful rectal examination may disclose a mass posterior to the bladder due to the persistence of the lower ends of the Müllerian ducts.

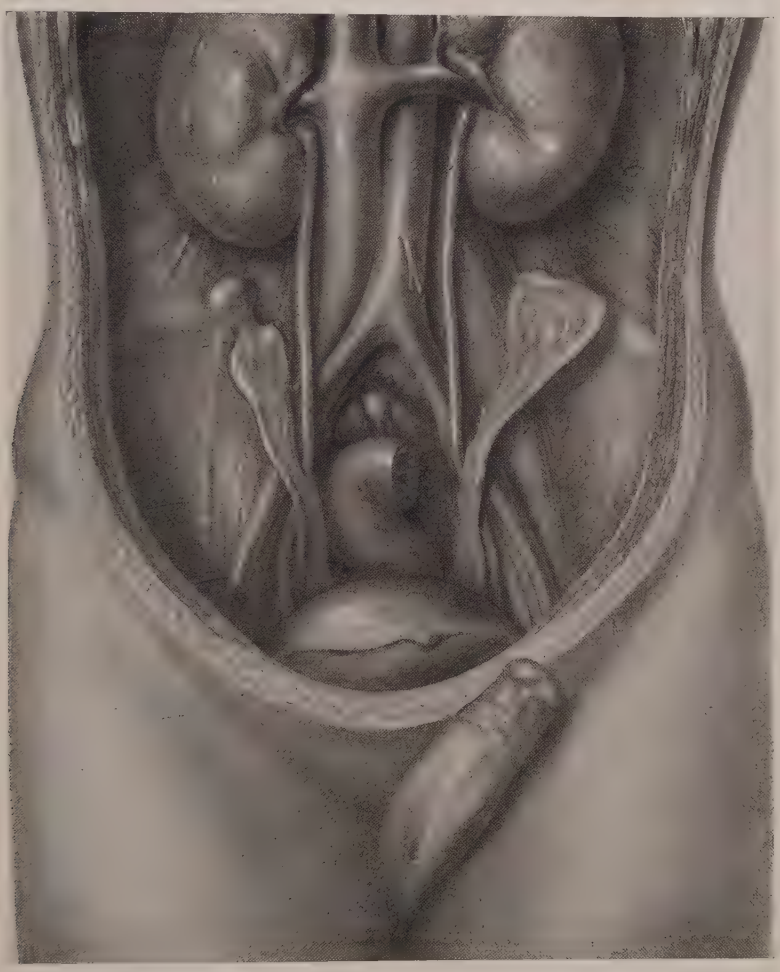

FIG. 607.—Hypospadias with undescended testicles. Death from influenza. Autopsy. Right testicle found just beneath right kidney. Left testicle absent. Peculiar broad fold of peritoneum with obliterated tube found on left side. B. U. I. 7069.

These lesser degrees of persistence may occur in individuals having no external abnormality of the genitalia. Any of the above forms may coexist with cryptorchidism, in which case the Müllerian structures are not found in the inguinal canals.

An excellent example of such a case was seen and described by Young and Cash from our clinic. The patient, who had undergone an operation for reconstruction of a hypospadiac urethra, succumbed to pneumonia. Autopsy revealed a large

sausage-like structure posterior to the bladder, and communicating with the urethra at the verumontanum (Fig. 606). At its upper end it divided into two tube-like structures, which terminated, one in the neighborhood of an abdominal retained testis, the other in the neighborhood of a small fibrous nodule which represented the remains of the other gonad. The testis was also provided with a normal arrangement of epididymis and vas deferens.

The persistence of the Müllerian ducts may be only partial. If at the lower end, this results in an enlargement to any degree of the prostatic utricle, which may extend up between the seminal vesicles, or be confined to the prostate. The utricle may be bifid or double. Such anomalies may sometimes be discovered by probing the utricle, and utriculograms might even be taken after injecting with an opaque medium.

In other cases the Müllerian ducts are obliterated only at certain points, leaving epithelial lined cavities. These may be collapsed or cystic. Thus we may have, instead of a ductus aberrans, a single cyst in the spermatic cord, or a series of cysts along its course, or there may be retrovesical cysts of similar origin. Normally, a vestige of the uppermost end of the Müllerian duct remains in the form of the hydatid of Morgagni. This structure may become enlarged and cystic, when it is difficult to distinguish clinically from spermatocele. Likewise a vestige in the funicular region, if it becomes cystic, is difficult to distinguish from hydrocele of the cord.

Finally, the utricle may be smaller than normal, or absent.

There may possibly be a relation, at least in some cases, between anomalies of the lower Müllerian structures and congenital valvular structures in the urethra. The utricle may be much enlarged as, for example, in the case pictured in Fig. 570, where increased urinary pressure alone could not possibly account for the great dilatation.

The paradidymis, representing the remains of some of the Wolffian tubules which do not take part in the formation of the epididymis, seldom becomes cystic.

The seminal vesicle, ampulla, and vas may be absent, even when the testis of the same side is present and normal. Vesicle and vas may exist when there is no epididymis, but if the epididymis is present, the other structures are usually present also. The vesicle and vas may be hypoplastic, but gross alterations in form are very rare, although the degree of complexity of the lumina of these organs varies greatly.

The ejaculatory ducts seldom join before entering the urethra, but may do so. More frequently they open into the utricle. As mentioned previously, a ureter may open into the seminal vesicle or ejaculatory duct. The ejaculatory ducts usually empty below the utricle, but may lie alongside it or above it.

The vas practically always runs to the corresponding testis, whatever its position. In cryptorchidism the vas may be quite redundant, and be prolapsed below the testis in the inguinal canal. This possibility must always be kept in mind in operations for undescended testis.

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CHAPTER X

TRAUMATISM AND FOREIGN BODIES OF THE UROGENITAL TRACT

TRAUMATISM OF THE KIDNEY

The kidney may undergo traumatism as the result of blows on the exterior of the body, or as the result of wounds with penetrating weapons or projectiles.

Rupture of the Kidney.—In the former case the integument is not usually broken, so that these are commonly called *subparietal ruptures*. Subparietal ruptures are further divided into (1) those due to direct violence, applied over the site of the kidney; (2) those due to indirect violence, where the blow is applied at a distance, as by a fall on the feet or buttocks, and (3) those due to very severe muscular effort.

Rupture due to direct violence is by far the most frequent. In a series of 43 cases reported by Keller[1] 27 were due to direct violence, in 15 the nature of the injury was uncertain, in only 1 was the violence indirect, and none could be attributed to muscular effort. The mechanism of the direct variety is that of a crushing force applied to the kidney, between the abdominal wall containing the twelfth rib, in front, and the posterior parietes behind, the kidney resting on the muscles and lateral processes of the vertebræ and being contained on the medial side by the vertebral bodies. To the crushing force is sometimes added an element of shearing, when the crushing object also moves across the body. The kidneys can escape only by moving up and down. Such movement is easier for the left kidney, the right kidney being somewhat restricted by the liver. In accordance with this, the right kidney is more frequently injured, in the ratio of about 10 : 7 (Keller). In Küster's series of 272 cases the injury was on the right side one hundred and forty-two times, on the left side one hundred and eighteen times, and bilateral twelve times.

It has long been noted that it is very difficult to produce injuries of the kidney by delivering blows upon dead bodies. Küster[2] found the answer to this by experiments in which he showed that if the blood-vessels of the kidney were filled with fluid under tension, the organ would rupture much more easily. This rupture is in the nature of an explosion, with fissures radiating usually from the hilum, and, therefore, roughly transverse to the long axis of the kidney.

Injury to the kidney is by no means always proportional to the severity of the general injury. This is no doubt due to the necessity, ordinarily, for a direct impact on the kidney. Even a severe impact, if somewhat eccentric, allows the kidney to escape. A general increase of intra-abdominal pressure, however great, could not cause the sort of explosive injury usually seen, and described above. The proportion of trunk injuries in which kidney ruptures occur is, therefore, of interest. The following figures may be quoted: Küster, 9 ruptures of the kidney in 7741 cases with contusions; Morris, 9 ruptures of the kidney in 9800 surgical cases; Herzog, 17 ruptures of the kidney in 7805 operations; Keller, 43 ruptures

[1] Archives des Maladies des Reins et des Organes Génito-Urinaires, 1922, i, 137–167.

[2] Archiv für Klinische Chirurgie, 1895, l, 676–686.

of the kidney in 83,000 surgical cases. In the surgical records of the Johns Hopkins Hospital there are 25 injuries of the kidney among 62,000 surgical cases. Of these, 11 are designated rupture of the kidney, 13 contusion of the kidney, and 1 laceration of the kidney by a stab wound. Variation of the figures is to be expected according to the proportion of traumatic cases seen in the different clinics, but in general hospitals about 1 case of kidney injury in 2000 surgical cases can apparently be expected. The kidney is somewhat more subject to contusion than the liver or spleen. In the 62,000 Johns Hopkins Hospital cases mentioned above, there were 8 ruptures of the spleen and 6 of the liver. Over 90 per cent. of the cases are in men, and are mostly in early adult life, when the most strenuous vocations are followed. The recent great increase in automobile accidents in this country has caused a number of cases, especially in children.

The mechanism of the so-called *indirect rupture of the kidney* is not satisfactorily explained. It is usually ascribed to the inertia of the kidney and its fluid contents acting after the fall of the body has been abruptly arrested. It is certainly very rare, and in most of the cases described the injury to the kidney has been slight.

Similar comment may be made on the *rupture "by muscular effort."* Most writers assume a sudden, spasmodic contraction of the abdominal muscles, forcing the ribs against the kidney, as in the effort of carrying or catching a heavy weight, or of trying to avoid a fall. This type of case is of considerable medicolegal interest, as it is often invoked when hematuria follows a severe effort made during work. Kretschmer,[1] who has seen many such cases in connection with workingmen's compensation insurance, is inclined to believe that in many, if not most of them, there is a pre-existent but unsuspected kidney lesion, such as pyelitis, calculus, tuberculosis, or neoplasm. It has been noted that kidneys the seat of hydronephrosis or pyonephrosis may rupture more easily than normal kidneys.

Pathologically, one usually sees the radiating fissures above described. The fissures may involve the parenchyma alone, or may extend into the pelvis or calices. This difference is important, as Tuffier[2] has shown that the exposed surfaces of the parenchyma do not secrete urine under these conditions, and therefore there will be no urine mixed with the hemorrhagic extravasation unless the pelvic cavity is opened. When the parenchyma is ruptured the fibrous capsule usually breaks with it, but occasionally does not. Küster also describes tears in the fatty capsule or perirenal tissues not involving the kidney proper. The degree of the tearing varies. There may be only one fissure, but this may extend clear across the organ, separating it into two parts. Portions of the parenchyma may be torn off the pelvis. In the severest cases the entire kidney is broken into small pieces.

Blood-vessels are always torn, so that hemorrhage is constant. Its severity depends on the size of the vessels involved. The location of the rupture is important in prognosis and treatment, as portions of the kidney the arterial supply of which has been torn across will inevitably undergo infarction.

Complications are not infrequent. Injury to the *ureter* produces surely urinary extravasation, and if it is torn completely across, no blood or urine can reach the bladder. The *pedicle* of the kidney may be torn completely across. This, of course, causes immediate cessation of urinary secretion, but the bleeding is very severe. The *peritoneum* may be torn, allowing blood, or blood and urine, to enter the

[1] Surgical Clinics of North America, 1922, ii, 801–810.

[2] Études éxperimentales sur la chirurgie du rein, Paris, 1889.

abdominal cavity. In de Quervain's[1] series of 254 cases of rupture of the kidney, the peritoneum was torn in 17. The peritoneum may tear secondarily, due to pressure from the extravasated blood mass, or to weakening from an infectious process. If urine enters the peritoneal cavity, peritonitis is sure to follow, unless perhaps the flow is so slight that it can be walled off by adhesions.

Other organs may be injured, especially the spleen, liver, and intestine. It is unnecessary to go into the details of these injuries here, but one should always keep them in mind when examining traumatic cases.

Infection is quite apt to occur, surely if the kidney has previously been infected. If not, hematogenous infection may occur. The experiments of Brewer[2] should be remembered, in which he was able to cause a unilateral renal infection by bruising a kidney, and then injecting intravenously colon bacilli or other organisms. The extravasated blood acts as a culture medium, and large abscesses are produced. The presence of urine aggravates the process.

Hemorrhage is the chief complication. It may be entirely extrarenal, entirely confined to the pelvis (hematonephrosis), or may involve both the kidney and perirenal tissues. The last is the rule. Cessation of the hemorrhage depends generally on the extent of the injury. Thus, if the true capsule is intact, the hemorrhage is seldom extensive. Perirenal accumulations may develop enough pressure, if the peritoneum is not ruptured, to stop the bleeding. If the peritoneum is ruptured, the loss of blood is usually much more severe. Secondary rupture of the peritoneum, or operative incision of the blood mass may cause the recurrence of serious hemorrhage. When arteries are torn, especially in the pedicle, an encapsulated hematoma, the so-called dissecting or traumatic aneurysm, may occur, which is capable of reaching great size. Perirenal hemorrhage may spread in the connective tissue, usually lifting up the posterior parietal peritoneum, sometimes filling the entire flank. Extension to the other side does not occur, but the space under the diaphragm may be filled, or the blood may creep along the psoas fascia, causing ecchymosis over the femoral triangle, or along the spermatic vessels, causing inguinal and scrotal ecchymosis.

Urinary extravasation is a serious complication, but not as severe as extravasation from the lower urinary tract, since the urine in the kidney is under much lower pressure. The maximum possible is the secretory pressure or about 60 mm. of mercury, whereas fluid may be ejected from the bladder at a pressure three times as great. The urine is usually mixed with blood and infiltrates the tissues, but occasionally may become encysted. These urinary cysts are extrarenal, and should be distinguished from hydronephrosis caused by traumatic stricture of the ureter or pelvis. This distinction is not always carefully made in the literature.

Late complications may occur from injuries to the pelvis or ureter leading to obstruction, so that hydronephrosis, partial or complete, may occur. Infection is not uncommon in these cases and aggravates the condition. Herrick[3] believes that the slighter grades of injury may also produce obstruction and eventual dilatation by causing increased mobility of the kidney and kinking of the ureter. If the opposite kidney is not sound, the traumatic destruction or subsequent obstructive

[1] Quoted by Wagner, Schmidt's Jahrbücher der in-und ausländischen gesamten Medizin, 1920, cccxxxii, 111–122.

[2] Surgery, Gynecology, and Obstetrics, 1906, ii, 485–497.

[3] Journal of Urology, 1921, v, 1–17.

changes may produce renal insufficiency and uremia. In healing, the parenchyma undergoes some fibrosis, and the secretory apparatus may apparently be affected, so that there is sometimes persistent albuminuria. Keller was able to prove in 2 such cases by ureteral catheterization, years after the injury, that the albuminuria was unilateral and came from the injured side. Dislocation may cause late pain.

The kidney heals with scars corresponding to the fissures and infarcts. Evidence of epithelial hyperplasia has been seen, but there is no new formation of tubules.

The *symptoms of rupture of the kidney* are hematuria, pain, and tumor. There are often anemia and collapse, if the peritoneum is torn the symptoms of peritonitis, and if other organs are injured the symptoms appropriate thereto.

Hematuria is very constant, being noted in 95 per cent. or more of the cases in the literature. Apparently it is always present in slight injuries, and absent only (1) when the ureter is torn completely across; (2) when the pedicle is torn completely across, or (3) when the bladder or kidney pelvis is completely filled and obstructed by clots. If the pelvis is not torn, some blood will always come down the tubules and be mixed with the urine. The hematuria is only rarely delayed, and usually appears with the first voiding. If the bladder is filled with clots, there will be distention, vesical pain, and amictio. The catheter will bring away a little bloody fluid. Secondary increase in hemorrhage may occur as above noted, and hematuria may persist for a long time, although in 56 per cent. of Keller's cases it ceased within a month. Sometimes old blood (coffee-ground material) may be eliminated in the urine.

Local *pain* in the kidney region is the rule and may be severe and accompanied by muscle spasm. Ureteral colic and vesical pain may occur as the consequences of obstruction by blood-clots. Fieschi[1] reports a case in which the pain was on the opposite side from the injured kidney.

Tumor is due to the extravasation of blood or of blood and urine. It is in the kidney region and spreads into the flank. The rapidity with which it increases in size is a rough index of the severity of kidney injury. There is no tumor when the peritoneum is torn, and secondary rupture of the peritoneum may lead to a rapid disappearance of the tumor. Edema and ecchymosis may occur, as stated above, in the inguinal, scrotal, or femoral regions, but practically never in the loin, unless due to local injury of the abdominal wall or fracture of a rib.

Peritonitis is indicated by the usual symptoms, hiccough, vomiting, distention, pain. Similar symptoms are sometimes observed in cases where there is no tear of the peritoneum. With infection there are fever and prostration. As a result of the injury itself, there is often immediate shock, with pallor, cyanosis, syncope, etc. Later a sort of secondary shock, due largely to hemorrhage, may occur.

The *diagnosis of rupture of the kidney*, except in those cases where there is no hematuria, is usually not difficult, but it is difficult to determine the extent of the injury, and whether operation is demanded or not.

The story of the injury should be carefully ascertained whenever possible. The amount of shock present does not necessarily run parallel with the extent of the injury.

The entire physical examination must be thorough to discover other injuries. Study of the urine will usually disclose blood, in quantities visible to the naked eye, or as red blood-corpuscles seen with the microscope. In a patient comatose

[1] Archiv Italien de Chirurgie, 1921, iii, 305–310.

with shock, urine may not be available, in this case palpation of the kidney region may reveal a tumefaction. The advisability of catheterization is discussed in a subsequent paragraph.

If there is hematuria, it is first necessary to rule out rupture of the urethra or bladder. Here the *x*-ray is of assistance, since rupture of the juxtavesical urethra is rare except with fracture of the pelvis. In rupture of the urethra it is usually impossible to introduce an instrument into the bladder, there will be swelling in the perineum or the prevesical region, and local signs in the kidney regions will be lacking. In rupture of the bladder the location of the tumefaction and absence of kidney signs are helpful if the tear is extraperitoneal; if intraperitoneal, the signs of peritoneal irritation usually soon dominate the picture. The kidney regions show nothing, and the laparotomy, which is urgently demanded, enables one to exclude renal injury entirely.

If it is the kidney that is injured, renal pain, tenderness, muscle spasm in the flank, and a mass are usually present. The urine may contain long worm-like ureteral clots. The *x*-ray shows nothing unless there be pre-existent calculus or calcified tuberculosis. In such cases, hematuria may be caused by trauma without any perirenal hematoma.

If there is no hematuria, there may be at the same time the signs of vesical retention, if the bladder is filled with clots, or clear urine may be passed, if the ureter has been torn. If there is vesical retention, efforts must, of course, be made to relieve it, and these will disclose the blood. Cystotomy should never be done in such cases until the surgeon has satisfied himself by the most careful examinations that there is no lesion higher up in the urinary tract.

If clear urine is obtained from the patient, there is danger that injury to the kidney may be missed. Since, however, this condition is associated usually with the severest types of renal traumatism, local signs will probably be present. For this reason, we may repeat the warning of Carlier and Heitz-Boyer[1] that "it is necessary to explore systematically and minutely the lumbar region of every individual who has sustained an abdominal traumatism, even if he has passed no blood in the urine." In a few cases there is a complete anuria for a time following unilateral renal injury, which is explained as a reflex inhibition.

Peritoneal tear is always accompanied by free fluid in the peritoneal cavity, usually a mixture of blood and urine, giving movable flatness in the flanks. When this is discovered two other possibilities must be considered: (1) Some free fluid is sometimes present in the peritoneal cavity without any rupture of the peritoneum, and (2) there may be injury of other abdominal viscera, as the spleen, intestine, or liver, which, of course, can be the case with or without rupture of the juxtarenal peritoneum. Peritoneal involvement is usually accompanied by pain, nausea, vomiting, hiccough, and general muscle spasm, and later distention. If the renal injury communicates with the peritoneal cavity through a rent in the peritoneum a local hematoma usually does not develop.

Infection may occur at any stage of the condition, and is a serious complication. There are fever, increased pain, and leukocytosis. Peritonitis causes an increase in the abdominal symptoms, with prostration, hippocratic facies, etc. Anemia due to the hemorrhage may be estimated by pallor, tachycardia, lowered blood-pressure and later decreased hemoglobin.

[1] Encyclopædie Française d'Urologie, 1914, ii, 185–226.

The use of the cystoscope and other instruments is of doubtful wisdom, on account of the danger of introducing infection in an especially susceptible field. Some authors would interdict the use of instruments entirely where there is the slightest possibility of peritoneal involvement. It is, however, sometimes necessary to relieve vesical distention due to clots, and if there is time before an operation, the functional capacity of the supposedly sound kidney should be investigated. Once instruments have been introduced, the diagnosis must be completed at once, and operation performed without delay. Attempts to make pyelograms of injured kidneys are not justifiable, as the injection fluid, possibly infected, may spread to the perirenal tissues or peritoneum. In case immediate operation is unavoidable, it may be desirable to explore the sound kidney, as cases are on record where single kidneys have been removed after injury.

Since many injuries are slight and are recovered from without operation, the question arises in each case whether operation is indicated. In some cases the injuries are so extensive and the shock so great that nothing can be of any avail. Experience is the only guide in such instances. In any case, if primary traumatic shock is present, it should be combatted by the well-known measures of rest, morphin, heat, and fluid. Transfusion of blood may be necessary. The indications for operation are: (1) Signs of peritoneal involvement, especially free fluid; (2) rapidly increasing signs of hemorrhage, either primary or secondary (pallor, fall of blood-pressure, tachycardia, increasing size of tumefaction, or loss of much blood with the urine, and (3) signs of infection (fever, leukocytosis, prostration). Late hydronephrosis and pyonephrosis demand operation, but these are not matters of urgency.

Treatment.—If expectant treatment is decided on, every effort should be made to avoid infecting the bladder, and to keep the patient absolutely quiet. He must also be closely watched, as operation should not be delayed if infection supervenes, or the loss of blood becomes dangerous. By waiting too long, a stage may be reached in which the patient's powers of resistance are so lowered that he has little chance of withstanding the operation.

Results are quoted as follows: Keller, of 478 cases not operated upon, 107 (22 per cent.) died, 60 of hemorrhage, 38 of infection, and 9 of other causes. Suter, of 427 cases not operated upon, 88 (20.6 per cent.) died. Of 143 cases operated upon conservatively, 21 (14.6 per cent.) died. Of 131 cases operated upon by nephrectomy, 22 (16.7 per cent.) died. Total 701 cases, of which 131 (18.6 per cent.) died.

Wounds of the kidney include, of course, an external wound as well. The situation of the kidney is such that it is almost impossible for a wound of the kidney to occur without a wound of some other organ—spleen, liver, intestine, stomach, pancreas, lung, or spinal column. Wounds may be classified as: (1) Those due to piercing instruments (bayonet, dagger, spike), etc., (2) those due to cutting instruments (saber, machete, saw, etc.), and (3) those due to firearms (bullet, shell fragment). Such wounds are comparatively rare. In warfare they are infrequent in the hospitals, as wounds involving the kidney are often quickly fatal.

The pathology varies with the nature of the wound. In those due to rapidly moving missiles an explosive effect is often seen which occurs when the wound is acquired at short range. At very long ranges a bullet may "tumble" and striking sideways, produce a variety of tearing, bruising, and explosive effects; the same

thing after a "ricochet." Rifle bullets at medium range may produce cleanly perforating wounds; the same is true of pistol bullets, which seldom cause explosive effects, due to their lower initial velocity, unless the muzzle is pressed against the body. Shell fragments, being irregular, often cause extensive destruction, as may also fragments of bone driven before a projectile.

If a small wound tract is produced, there may be little external bleeding and a hematoma may be produced as in contusion. The peritoneum is often wounded, but effusion of blood and urine into it may be absent if the kidney wound is small. In larger wounds peritoneal involvement is common, there is severe hemorrhage to the outside, and infection is unavoidable. Secondary hemorrhage may occur if a vessel has been tangentially injured; in the case of an artery an encapsulated hematoma or dissecting aneurysm may be produced. In modern warfare, with its large proportion of shell wounds, foreign materials (clothing, earth, etc.) are often driven into the wound and aggravate the infection.

The two striking *symptoms* associated with kidney wounds are hematuria, and the escape of urine from the wound. The latter often does not commence at once after the reception of the wound, and will not occur at all unless the pelvis has been opened. Perirenal hematoma is not to be expected. The urinary fistula, rarely, persists for long periods.

The *diagnosis* is made by the above symptoms, and by reconstructing the tract of the missile or object that has caused the wound. In multiple bullet wounds this is often difficult, when the *x*-ray may help to solve the problem.

According to statistics furnished by the Medical Department of the United States Army, 51 of 77 cases of wounds of the kidney in the Civil War had a fatal outcome, a death rate of 66.2 per cent. In the World War there were 129 cases of wounds of the kidney tabulated among 170,841 battle casualties, and of these 75, or 58.1 per cent., died. It must be remembered that wounds of the kidney are practically always associated with wounds of other important organs, and also that many, for this reason, die on the battle field, and never figure in the statistical tables.

In the World War the kidney injuries tabulated for the United States Army were divided as shown in Table 145, page 144.

In 93 cases of kidney wounds complicating conditions were noted as follows: Influenza 1, arthritis 1, psychosis 1, hemorrhage 11 (10 deaths), hematoma 1 (1 death), hemothorax 7 (5 deaths), suppurative pleurisy 4, bronchopneumonia 6 (4 deaths), lobar pneumonia 1 (1 death), pneumothorax 2 (1 death), peritonitis 6 (6 deaths), cystitis 2 (2 deaths), hematuria 3 (1 death), acute nephritis 1 (1 death), uremia 1 (1 death), abscess 3, gangrene 1 (1 death), gas bacillus infection 2 (2 deaths), secondary hemorrhage 1 (1 death), surgical pyemia 1 (1 death), septicemia 5 (5 deaths), wound infection 8 (2 deaths), other infections 12 (5 deaths), acute pulmonary edema 1 (1 death), shock 11 (10 deaths), total 93 (61 deaths).

Nephrectomy was recorded twenty-seven times, with 8 deaths, and nephrorraphy, or repair of the injured kidney by suture, nine times, with 2 deaths.

TRAUMATISM OF THE URETER

Ruptures and Wounds of the Ureter.—The effects of a *rupture* of the upper ureter have been described in connection with rupture of the kidney. The lower ureter is rarely injured except during *surgical operations*, especially radical or

TABLE 145

Wounds of the Kidney, 1917–18

	Admissions.					Deaths.					Percentage of deaths.				
	Rifle ball.	Shell.	Shrapnel.	Not specified.	Total.	Rifle ball.	Shell.	Shrapnel.	Not specified.	Total.	Rifle ball.	Shell.	Shrapnel.	Not specified.	Total.
Kidney wounds	25	17	22	65	129	15	14	6	40	75	30.0	82.3	27.3	61.5	58.1
Total wounds	23,625	20,506	39,979	90,186	174,296	1167	1876	2315	8111	13,469	4.9	9.1	5.8	9.0	7.73

The mortality from kidney wounds is high, and in those caused by shell fragments the highest. This is undoubtedly due to the greater extent of such lesions, and the greater liability to concurrent injury of other organs.

vaginal hysterectomy, when it is not infrequently divided, or its blood-supply so injured that necrosis occurs. In such cases, if the accident is unnoticed, urinary fistula develops in the wound, and later cicatricial stricture may occur with hydronephrosis.

The ureter is so small that it is difficult to suture its ends together in such a manner that stricture will not develop. Various methods of end-to-end and end-to-side anastomosis have been devised, but none is very satisfactory. The method of choice is, when possible, to suture the upper end of the divided ureter into the upper portion of the bladder (vesico-ureterostomy).

To prevent accidental division of the ureters, it is best to place ureteral catheters in them preliminary to operations in which they may be wounded. They are then easily identified and kept from harm.

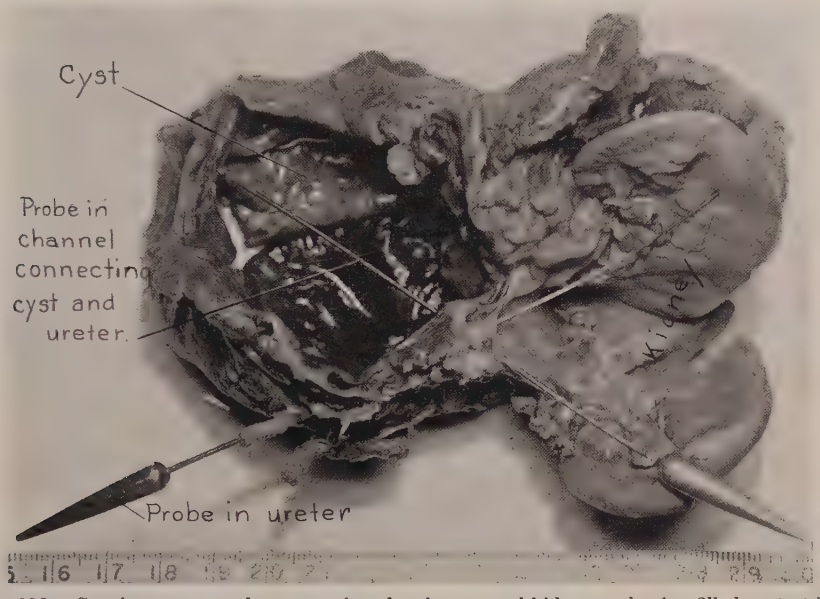


FIG. 608.—Specimen removed at operation showing normal kidney and urine-filled cyst at its lower pole. The small connection between the ureter and the cyst is indicated by a probe. There is also a probe in the ureter which was somewhat constricted by scar tissue just below the site of the channel connecting with the cyst. This condition was found two weeks after the patient had been run over by an automobile. J. H. H. Surg. 56,517.

Falls and contusions may cause partial rupture of the ureter, with extravasation of urine and blood. In 1 case seen by us (J. H. H. Surg. 56,517) a four-year-old boy had been run over by an automobile. There was some hematuria, which soon ceased, and the child appeared well. A week after the accident pain began in the right kidney region and a mass was noticed. When brought to the hospital there was severe pain and fever of 102° F., with only moderate leukocytosis. In the flank was a large, bulging, rounded, very tender mass. The urine was clear, and secreted in about the quantity to be expected. At operation, which was done immediately, the kidney was found to be practically normal, while at its lower pole was a cyst, with walls of moderate thickness and a diameter of about 12 cm. This cyst communicated directly with the ureter about $1\frac{1}{2}$ cm. below the ureteropelvic junction by a very small channel, admitting only the finest probe. Just below this channel was a partial stricture due to a cicatrix. There was

slight if any hydronephrosis (Fig. 608). Nephrectomy was done, and was followed by an uneventful convalescence. In this case the tear in the ureter had evidently been so small that the slowly escaping urine was encapsulated, and no infiltration of the tissues occurred.[1]

Other ways in which the ureter may be wounded are (1) by prolonged pressure of the fetal head in difficult labor (necrosis), (2) by projectiles, weapons, or pointed objects (very rare), and (3) by puncture with ureteral catheters. The last practically never occurs except in rare cases where the wall of the ureter is diseased, as in tuberculosis or the ulceration about a calculus. The present increased use of metal ureteral instruments may make this accident less rare. In a very few cases a prolapsed ureter has been injured during herniotomy.

Symptoms.—Where there is rupture of the ureter, a tumefaction will be present unless there is communication with the peritoneum. The question of diagnosis is then between hematoma and urinary cyst, and in any case operation is in order, at which time the *diagnosis* will be settled.

In the United States Army during the World War only 4 wounds of the ureter were tabulated, with 2 deaths, a mortality of 50 per cent.

TRAUMATISM OF THE BLADDER

Injuries of the bladder consist of ruptures, caused directly by increased internal hydrostatic pressure, and of wounds produced by the passage of some foreign object.

Rupture of the Bladder.—There is little accurate information concerning occurrence of ruptures of the bladder. Apparently, however, they are seen, generally speaking, about as often as ruptures of other abdominal organs, the protection afforded by the pelvic bones being offset by the greater liability to overdistention.

Rupture of the bladder can occur only when the bladder contains fluid. The more it contains the more likely it is to rupture. Pathologic conditions (atony, ulceration, infiltration) may weaken the bladder so that it ruptures more easily. When there is only a small quantity of fluid, the bladder is entirely within the pelvis, and is extremely unlikely to be ruptured by any violence unless it be great enough to crush the pelvis. Even then the bladder usually escapes. The force acting to cause the bladder to rupture may be (1) external violence, (2) muscular effort, and (3) forcible injection of fluid. It is probable that the normal, unobstructed bladder never ruptures from muscular effort, no matter how much urine it contains. It may, however, be ruptured by external violence when distended. An accessory cause is then any influence which allows the bladder to become overfilled, as pre-occupation, anesthesia, or drunkenness. Such ruptures are, therefore, commonest among athletes, soldiers in battle, and intoxicated persons. Bladders greatly overdistended from obstruction or atony are much more prone to rupture after a slight blow. Thus paralytics and patients with prostatic obstruction may suffer vesical rupture after such a minor accident as falling out of bed. In pregnant women the fetus may cause vesical retention, and rupture can occur from a blow or at labor. In one interesting case the bladder was ruptured by steam generated during a Bottini operation. In the same way we may assume that ruptures occuring after a sudden muscular effort indicate a pre-existing lesion,

[1] Compare Herbold, Archiv für Klinischen Chirurgie, 1904, lxxiv, 455.

as obstruction, atony, or inflammation. A list of the varieties of trauma which can produce rupture could be extended without limit, and need not be included here. A very thorough analysis has been made by Rouvillois and Ferron,[1] which may be consulted by those interested.

Very rare are the cases in which the bladder ruptures from the violent contraction of its own musculature. Analogy is made with the spontaneous rupture of the hypertrophied heart, but convincing examples are lacking. One usually has to assume a large muscular hypertrophy associated with a rather rapidly developing obstruction, and at the same time a lesion of some sort weakening one spot in the bladder wall.

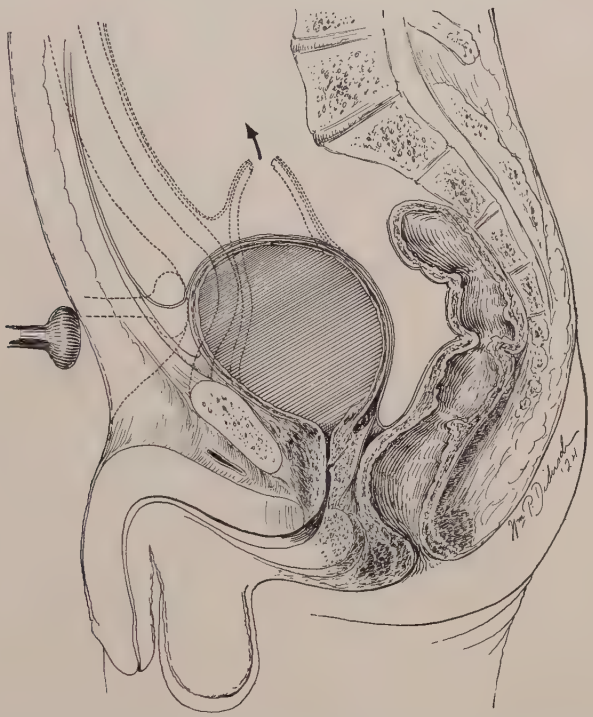


Fig. 609.—Diagram showing the mechanics of a rupture of the full bladder from a blow on the anterior abdominal wall. The bladder being compressed, ruptures at the point of least resistance which, under these circumstances, is usually into the peritoneal cavity. This diagram is taken from the article by Rouvillois and Ferron in Vol. IV of the Encyclopædie Française D'Urologie.

The rupture may be *intraperitoneal* or *extraperitoneal*. The former is more frequent, indeed many of the latter are probably tears of the bladder rather than ruptures due to hydrostatic pressure. In general, the rupture occurs at the point farthest from the point of impact which is freest to expand. The base, the lower part of the posterior aspect, the sides, and the anterior wall are all supported by the surrounding pelvic structures. Since the blow is usually on the lower abdominal wall, it follows that a frequent site of rupture is the upper, median part of the posterior aspect. This will be intraperitoneal, as a rule. (See Figs. 609 and 610.)

Rarely the rupture is partial, not involving the entire thickness of the bladder wall. An example of this is found in the ruptures purposely produced in the diag-

[1] Encyclopædie Française d'Urologie, 1921, iv, 89–176.

nosis of interstitial or submucous cystitis. (See the section on Infections of the Bladder.) Here the mucosa and submucosa, made rigid and friable by infiltration, crack, while the muscularis remains intact. Very rarely the peritoneum remains intact over a rupture—at least for a time—so that a urine-filled bleb is produced. Ordinarily the bladder is not ruptured by the artificial introduction of irrigating fluid unless it is the seat of extensive lesions which weaken its wall. This possibility, however, is a strong argument in favor of gravity apparatus rather than syringes for distending the bladder.

Rupture of the bladder during cystoscopy, litholapaxy or other form of intravesical instrumentation is much more common than indicated by the literature or text-books.

Fig. 610.—Diagram showing the mechanics of rupture of the partially filled bladder from a blow on the anterior abdominal wall. Bladder is apt to fold up under these circumstances as shown, and the rupture, at the point of least resistance, is more apt to take place extraperitoneally into the retrovesical tissues. This diagram is taken from the article by Rouvillois and Ferron in Vol. IV of the Encyclopædie Française D'Urologie.

Hemorrhage from rupture is usually not sufficient to endanger life. The two important complications are extravasation of urine and infection. The course of events depends somewhat on the size of the rupture. If it is small, a certain amount of urine will collect in the bladder, part or all of which is then forced out, by the contraction of the bladder muscle, into the peritoneal cavity or into the perivesical tissues. If the rupture is large, the bladder may contract down so that the urine flows into the surrounding regions without even partially distending it. No resistance is encountered in the peritoneal cavity, but when the rupture is extraperitoneal, the urine infiltrates the adjacent tissues more rapidly and extensively than it does in injuries of the upper urinary tract. Exceptions to this rule are in paralytic bladders, and in those with very small ruptures and unobstructed outlets, where the greater part of the urine passes through the urethra.

The consequences of the extravasation of urine into the peritoneum are the same, regardless of its source. When sterile, it causes irritation and intoxication, and infection is very apt to occur. Any instrumentation is very likely to be followed by infection and peritonitis. If the bladder is infected at the time of the rupture, acute infectious peritonitis begins at once. Walling off by adhesions is very exceptional.

When the rupture is extraperitoneal, the tissues are infiltrated with urine according to the location of the rupture. If on the anterior wall, a prevesical tumefaction of the lower abdomen is observed. If posterior or lateral, the spread is at first retroperitoneal, and masses can be felt or seen in the groins. All extravasations, however, are apt to spread around the bladder, so that often both prevesical and retroperitoneal accumulations are seen. The rectum may be surrounded, and the mass extend high up retroperitoneally in the abdomen. Not infrequently it reaches the region of the kidney. The triangular ligament prevents spread into the perineum, and only rarely does any tumefaction occur in the ischiorectal fossæ. The urine may, however, reach the subcutaneous layers at which level it spreads more widely. Necrosis follows rather rapidly and infection is practically certain to occur. Rupture to the outside may occur with discharge of pus, necrotic tissue, and urine. Spontaneous improvement may follow this event. Even absorption of sterile urine causes some fever and intoxication.

With the advent of *infection* the lesion is turned into a cellulitis with gangrenous abscesses. Thrombophlebitis may occur, and give rise to septicemia or embolism.

Fistula may be left in cases which recover, and may extend from the bladder to any point reached by the extravasation.

The *symptoms of rupture of the bladder* are sometimes masked at first by traumatic shock. A few cases are reported in which primary shock was entirely absent. The patient may feel a sense of something giving away in the lower abdomen at the time of injury. Pain is practically constant, and from the beginning. If the rupture is intraperitoneal, it soon takes on the character of peritoneal pain, and there may be vomiting and distention. If extraperitoneal, the pain may be localized in the lower abdomen, and may radiate to the perineum, penis, or legs. Desire to void is usually strong, sometimes amounting to tenesmus, but except where the rupture is very small no urine can be passed. If any urine is obtained, it is bloody. Fever may occur, and be increased by the onset of infection. There is often, especially in the later stages, intoxication due to absorption of urine or to sepsis, or to both, and some patients die apparently of uremia.

The *diagnosis of rupture of the bladder* can sometimes be made from the history alone. In other cases doubt persists. We may divide the signs into those characteristic of all ruptures of the bladder and those characteristic of, respectively, intraperitoneal rupture and extraperitoneal rupture. In all vesical ruptures we may expect pain, tenderness, fever, blood in the bladder, and, except in the earliest stages, a toxic general condition. In addition there is inability to void in all but the smallest ruptures. In intraperitoneal ruptures there are, negatively, absence of tumefaction and, positively, the signs of peritoneal irritation, with sometimes the demonstration of free fluid in the abdomen. In extraperitoneal ruptures there is, negatively, the absence of peritoneal irritation and, positively, a local tumefaction, which can be palpated either in the lower abdomen, the groins, or upon rectal or vaginal examination. In some cases in which the urine has passed

up beneath the anterior parietal peritoneum it may be recognized by palpation or percussion on one or both sides of the abdomen. Where the rupture is retrovesical and the urine travels up behind the posterior parietal peritoneum the mass may first be palpated or percussed above the crest of the ilium or in the loin. Unless the diagnosis has already been made and immediate operation decided upon, the absence of voiding will usually lead to catheterization. If the passage of the instrument is easy, urethral rupture is unlikely. If the rupture of the bladder is large, nothing will be obtained from the bladder but a little bloody fluid, though occasionally the catheter, penetrating through the rupture, may withdraw a large quantity of blood-stained urine from the peritoneal cavity. In this case the flow will have little force, and will be increased on each inspiration. If the rupture is small, variable quantities of blood-stained urine may be obtained from the bladder, and the diagnosis is more difficult. A procedure often followed is to introduce a measured quantity of fluid through the catheter; if it is impossible to recover it all, there is probably a rupture of the bladder. Ruptures following artificial distention of the bladder are usually discovered in this way, when the distending fluid fails to return. If this procedure is used, however, it should be done with the full realization that one may be introducing a quantity of infected fluid into the peritoneal cavity or perivesical tissues, and if the result is positive, operation should follow at once. In addition, this test is not infallible, as with small ruptures the entire quantity may be recovered, especially if only a small amount is introduced.

An ingenious test has been proposed by Vaughan and Rudnick.[1] A measured quantity of air (about 400 c.c., the capacity of the average bladder, but less in young individuals) is introduced through a catheter. The bladder may be viewed during the injection with the fluoroscope, or a roentgenogram may be taken immediately after the injection is completed. This should be done from the side, the patient lying on his back. If the bladder is intact, its outline is rounded and regular. If there is a rupture, the air will be seen in the pelvic tissues or prevesical space, if the rupture is extraperitoneal. If the rupture is intraperitoneal, the air will appear in the anterior part of the peritoneal cavity, above the intestines, and the bladder will be partially or entirely collapsed. This appears to be a reliable test, but, as in all other procedures where anything is put in the bladder, it should be followed immediately by operation if rupture is demonstrated.

Definite diagnosis may sometimes not be made until exploratory operation is carried out. If there is no marked perivesical tumefaction, it is important to open the peritoneum before opening the bladder, as it may be impossible to detect the effects of a small rupture of the bladder through the intact peritoneum, and its intravesical orifice may be missed after the bladder is opened.

The absence of voiding may be due to retention, anuria, or rupture of the urethra, as well as to rupture of the bladder. In retention, the enlarged bladder may be made out, and catheterization will cause its disappearance, with the recovery of a corresponding quantity of urine which is usually not bloody. This distinction is of some importance, as retention of urine may occur after various bodily injuries. Anuria is infrequent; with it there should be no blood in the eye of the catheter after withdrawal. Rupture of the urethra is more often associated with perineal or perirectal tumefaction and ecchymosis, and catheterization is usually impossible or difficult. While fracture of the pelvis usually accompanies

[1] Journal of the American Medical Association, 1924, lxxxiii, 9–12.

rupture of the urethra, its demonstration is not decisive, as it may coexist with rupture of the bladder as well. For the reasons mentioned, and because ruptures of the urethra and bladder may occur simultaneously, the diagnosis is often difficult, and can sometimes be settled only at operation. Consequently the exploration should be thorough.

In injuries of the upper urinary tract local signs are usually present, an approximately normal quantity of urine is obtained from the bladder, and voiding is natural unless there is clot obstruction, which will be disclosed by the catheter.

Occasionally, when seen in the late stages, the peritoneal signs may so dominate the picture that the bladder lesion is overlooked. Routine examination of the urine will usually prevent this mistake.

The following tables are taken from Rouvillois and Ferron:

TABLE 146

Results of Surgical Treatment of Intraperitoneal Rupture of the Bladder

	Cases.	Deaths.	Per cent.
Schlange, 1891	...	..	50
Sieur, 1894	34	20	58.8
Nobe, 1903	21	3	14.2
Alexander, 1903	45	23	51.1
Ashurst, 1906	110	47	42.7
Watson	...	..	42.2
Galactinoff, 1910 (personal)	15	10	66.6
Galactinoff (collected)	37	23	66.2
Hesse, 1912	16	10	66.4

TABLE 147

Results of Operation in Intraperitoneal Rupture of the Bladder According to the Time Elapsing Between Injury and Operation

	Total.				Before 1894.				After 1894.			
Interval between injury and operation.	Cases.	Recoveries.	Deaths.	Mortality, per cent.	Cases.	Recoveries.	Deaths.	Mortality, per cent.	Cases.	Recoveries.	Deaths.	Mortality, per cent.
From 1 to 12 hours	22	15	7	31.8	13	7	6	46.1	9	8	1	11.1
From 12 to 24 hours	21	10	11	52.3	12	3	9	75	9	7	2	22.2
Second day	24	12	12	50	8	3	5	62.5	16	9	7	43.7
Third day	13	9	4	30.7	7	3	4	57.1	6	..	0	0
Fourth day	5	3	2	40	1	..	1	100	4	3	1	25
Fifth day	1	1	..	0	..	..	..	..	1	1	..	0
Eleventh day	1	1	..	0	..	..	..	..	1	1	..	0
Total	87	51	36	41.3	41	16	25	60.9	46	35	11	23.9

Extraperitoneal ruptures are considerably less dangerous if uncomplicated, but the mortality rises rapidly in the presence of concomitant fractures or other lesions.

Wounds of the bladder may be produced (1) by projectiles; (2) by penetrating objects, either from without (bayonet, spike, etc.) or from within (cystoscope, lithotrite, etc.); (3) by fractured bones (fracture of the pelvis), and (4) during surgical operations. It is practically impossible for cutting weapons (saber, machete, etc.) to wound the bladder unless thrust in point first.

In general wounds are *tears* or *lacerations*, and *perforating wounds*. They are much more apt to be multiple than ruptures, and in the same way much more apt to be intraperitoneal and extraperitoneal at the same time.

While all wounds of the bladder are rare, by far the greater number are caused by projectiles from firearms, both in war and in civilian practice. In earlier wars and in civil life the missile is usually a pistol or rifle bullet, but in the recent war, in accordance with the great increase in the proportion of shell wounds, the majority of vesical wounds were caused by shell fragments.

In wounds made by projectiles a rifle or pistol bullet may make a small perforating wound without laceration, or, a bullet striking sideways or fired at short range, a shell fragment, a charge of shot, or any missile which strikes a bone before reaching the bladder may produce more or less extensive tears and destructive effects. The missile causing the wound may (1) pass on out of the body, (2) come to rest in the body after leaving the bladder, or (3) come to rest in the cavity of the bladder or in its wall.

The likelihood of a wound of the bladder by a projectile is increased when the organ is enlarged by distention. This is said to be an element in the production of some of the wounds of war since soldiers, in the excitement of battle, neglect to empty their bladders.

When the wounds are small and without laceration the picture is the same as in ruptures, taking into consideration the likelihood of multiple wounds, and of the injuries caused to other organs in the path of the missile. If they are extraperitoneal and very small, and no obstruction present, extravasation may be minimal and cause no serious trouble.

Where there are as many as two wounds, one of entrance and one of exit, one is almost sure to be intraperitoneal. If a bullet enters anteriorly, it may traverse the peritoneum to reach the bladder, or, if the bladder is distended, it may enter through that part of the anterior wall just above the symphysis which is not covered with peritoneum. Wounds which may have been in line with each other at the time of injury to a distended bladder will scarcely suggest it after the bladder has collapsed, the vesical wounds then being far below the abdominal wound. Where laceration occurs from bone fragments or irregular missiles the picture is greatly complicated by hemorrhage, tissue destruction and devitalization, and the presence of foreign material such as earth, clothing, shot, metal fragments, etc. Infection is inevitable in such cases. The urine may escape through the wound tract, or, if this is narrow and tortuous, infiltrates the tissues or enters the peritoneal cavity. Even where urine escapes to the outside, peritonitis is likely to occur if the peritoneum is torn. Missiles remaining in the bladder cavity—a rare occurrence—may be expelled by the urethra, or may remain, in which case they usually become encrusted and act as the nuclei of stones. Missiles embedded in the bladder wall usually ulcerate into its cavity, but may become encapsulated. Missiles coming to rest near the bladder may ultimately ulcerate into it.

In wounds made by penetrating objects from without the object usually enters

through the abdominal wall or perineum. Less frequent paths are by the obturator foramen, and sciatic notch, while if the force of the object is sufficient to enable it to fracture a bone which is in its path, the laceration is usually extensive and the damage great; comparable to that produced by irregular projectiles.

While the pointed object may be driven against the body from any direction, a large proportion of these injuries is due to falls, either on the abdomen or perineum. If on the perineum, the object is often guided by pressure of the thighs to the anus or perianal region, or, in women, to the vagina. The object then pierces the anterior rectal wall before entering the bladder, or in the case of the vagina, the anterior vaginal wall or vault.

Double wounds are less likely than in the case of projectiles, since much depends on the length of the object. If long enough, it will pass entirely through the bladder and make a second wound on the opposite side, beyond which it may wound other organs.

The complications are the same as those described for other wounds.

Wounds of the bladder caused by *intravesical instruments* are of especial interest to the urologist, since in these cases he may be himself the cause of the wound. Practically, they are confined to pathologic bladders, but an otherwise normal bladder may be penetrated without too much difficulty when in a state of spasmodic contraction. It should always be remembered, however, that diseased bladders may easily be punctured, especially in those conditions where an inflamed or ulcerated wall is combined with contracture. Tuberculosis, carcinoma, calculus, and interstitial or submucous cystitis may be especially mentioned. If the instrument enters a small diverticulum, its thin, non-muscular wall may also be penetrated.

These wounds are almost always in the median part of the lower posterior wall, though they may be in the vault, and for this reason are particularly apt to be intraperitoneal. It is seldom, however, that any other organs except the bladder and vesical peritoneum are injured. In a few cases the intestine has been wounded by a lithotrite, or even seized and drawn into the bladder or out of the urethra. Rarely the patient may wound his own bladder with some object inserted through the urethra.

It is a special feature of these wounds that they are not infrequently so small that the diagnosis may be difficult. The complications are the same as with other wounds of the bladder.

In fractures of the pelvis the bladder often escapes, owing to its elasticity, but in other cases it is torn by the displacement of the tissues surrounding it, or penetrated by a fragment of broken bone.

The condition is always serious, as there are, in addition to the complications produced by ruptured bladder (extravasation of urine, fever, intoxication), the shock and danger of the pelvic fracture, and the liability to osteomyelitis. Fortunately, however, the rupture of the bladder is often extraperitoneal. The laceration may be of any degree. It is sometimes very great, and in some reported cases the bladder has been torn entirely away from the prostate. There is an extravasation of urine mixed with blood, which may extend in any direction, as the fasciæ which ordinarily contain it may be torn. Infection often occurs, as it is usually impossible to avoid some instrumental intervention in the urinary tract.

Gangrene and cellulitis supervene, in the absence of proper treatment, with osteomyelitis, rupture to the outside, and discharge of necrotic tissue, urine, and sequestra. Sequestra may make their way into the bladder cavity. If the peritoneum is by chance torn, peritoneal irritation or peritonitis occur as described above.

The bladder may be wounded during surgical operations, especially those on the pelvic organs. Of especial interest, however, are those cases occurring during herniotomy, and due to the bladder being drawn into the hernia. This possibility must always be kept in mind. Perforations occurring during intravesical procedures have already been discussed, but similar accidents may happen during exploration from the perineum, as, for example, tears made by stone forceps. It is scarcely necessary to say that even properly sutured and drained incisions in the bladder may give passage to urinary extravasations if the outlet tube becomes blocked for any length of time. This happens more easily if the vesical incision is not sutured, as in the now obsolete procedure of slitting the mouth of a diverticulum, but proper postoperative care always prevents such accidents. With a freely open drainage-tube no extravasation will occur, even if the bladder is not intact.

Symptoms.—As far as the bladder is concerned, the symptoms of wounds of the bladder are the same as those of rupture of the bladder. There are also the symptoms arising from the other organs which may be wounded.

Diagnosis.—The diagnosis of bladder wounds is often complicated by the presence of other lesions produced at the same time. In general, the wounds without external orifice, including those made during intravesical manipulations, those made during surgical operations where free drainage is not provided, and those accompanying fracture of the pelvis, are diagnosed according to the same principles as ruptures of the bladder. Wounds with external orifices differ according to whether the wound tract is wide enough to allow urine to flow out, or whether it is so narrow that the pressure of its walls or the presence of blood-clots prevents the exit of urine. If urine escapes from the wound, there can be no doubt that the urinary tract is injured, and immediate operation is indicated. If urine does not escape from the wound, the diagnosis must be made by some of the procedures described under Rupture of the Bladder. Air injected into the bladder during operation escapes through the rupture and aids in its discovery.

Wounds of the bladder and urethra must always be thought of in any injury which involves the pelvis, and every effort made to exclude them. The difficulties arise when the external wound does not emit urine, or when there is no external wound. In these cases hemorrhage, edema, etc., from injuries of other pelvic organs may cause tumefactions indistinguishable from those caused by extravasation of urine. The same may be said of perivesical inflammation or abscess following injury or surgical procedure. In these cases the state of the urine is the most important point, and catheterization is often necessary. Hematuria may sometimes be caused by bruises of the bladder without actual solution of continuity, but whenever there is any evidence pointing to rupture or wound of the bladder, it is wiser to explore at once than to take chances by waiting. The onset of peritonitis during such a waiting period diminishes the patient's chances tremendously.

Table 148 gives the data of 15 cases of vesical traumatism treated in our clinic:

TABLE 148

B. U. I. No.	Operation.	Result.	Remarks.
Rupture traumatic. 4784	36 hours.	Died, 4 hours after operation.	Intraperitoneal. Cultures sterile. Died of shock.
Rupture instrumental. Lithotrite. 209	26 hours.	Recovered.	Subperitoneal and extraperitoneal. Closed.
587	17 days.	Died, 11 days after operation.	Stone on silk suture after radical operation for carcinoma prostate. Bladder not sutured. Extraperitoneal.
1619	+	Recovery.	Subperitoneal. Sutured.
Cystoscope. 1145	No operation.	Died.	Retroperitoneal.
3660	+	Recovered.	Rupture in diverticulum at dome of bladder. Extraperitoneal, extravasation incised.
8406	6 days.	Died, 26 days after operation.	Posterior wall, extraperitoneal (intraperitoneal?). Died of tuberculous peritonitis. (Tuberculosis of bladder and kidney.)
10,710	No operation.	Died, 3 days.	Intraperitoneal. Tuberculosis bladder and kidney.
?	Operation.	Died.	At operation, peritoneum was not opened, rupture was not found. Bladder drained. Autopsy showed urine in peritoneum and peritonitis.
Rongeur. 1436	No operation.	Died, 24 hours.	Posterior wall, intraperitoneal. (Small, recurrent lobule at vesical orifice.)
Punch. 2184	No operation.	Died, 2 to 3 days.	Small extravasation, trigone cut, also embolism. Extraperitoneal.
Rupture, cause? 3954	+	Died, few hours.	Carcinoma of bladder, intraperitoneal, ileus, enterostomy and cystostomy.
Extravasation after operation. 2314	24 hours.	Recovered.	Two-way catheter after suprapubic prostatectomy. Extraperitoneal. Incision of extravasation.
12,471	3 days.	Recovered.	Wound closed tight about suprapubic tube. Not sutured. Extraperitoneal.
Extravasation after suprapubic puncture. 5814	4 days.	Recovered.	Strictures, impermeable. Extraperitoneal. Not sutured.
12,493	48 hours.	Died on the table.	Intraperitoneal, peritonitis. Operation not completed.

The instrumental cases represent the dangers associated with any tearing or pulling maneuvers in the bladder. In the cases where no such thing was done, the damage was caused by pushing the instrument in too far, usually in a contracted or otherwise pathologic bladder. Note that in no case could the bladder be called normal.

Case 12,471 illustrates the danger after suprapubic cystostomy if the space of Retzius is not drained. Cases 5814 and 12,493 illustrate the two types of bad result following suprapubic puncture; in one an extraperitoneal extravasation along the track of the needle, in the other, perforations of the peritoneum with subsequent intraperitoneal extravasation and peritonitis.

In summary, it is seen that of 6 intraperitoneal ruptures, all died (4 were operated upon). Of 9 extraperitoneal ruptures, 3 died, 6 recovered. Of the 6 recoveries, all were operated upon, while only 1 of the 3 who died was operated upon.

According to the statistics furnished by the Medical Department of the United States Army, bladder wounds in the World War occurred as follows:

TABLE 149

WOUNDS OF THE BLADDER, 1917–18

	Admissions.					Deaths.					Percentage of deaths.				
	Rifle ball.	Shell.	Shrapnel.	Not specified.	Total.	Rifle ball.	Shell.	Shrapnel.	Not specified.	Total.	Rifle ball.	Shell.	Shrapnel.	Not specified.	Total.
Bladder wounds	33	17	8	67	125	14	7	6	40	67	42.4	41.2	75.0	59.7	53.6
Total wounds	23,625	20,506	39,979	90,186	174,296	1167	1876	2315	8111	13,469	4.9	9.1	5.8	9.0	7.73

In 94 cases of bladder wounds complicating conditions were noted as follows: diphtheria 2, influenza 2, cerebrospinal meningitis 1 (1 death), tetanus 1 (1 death), arthritis 1, aneurysm 1, hemorrhage 9 (8 deaths), hematoma 1, hemothorax 1, bronchopneumonia 4 (3 deaths), lobar pneumonia 1 (1 death), pneumothorax 1, peritonitis 11 (11 deaths), cystitis 2, hematuria 1, incontinence of urine 2, abscess 9 (3 deaths), gangrene 1 (1 death), gas bacillus infection 6 (3 deaths), secondary hemorrhage 1 (1 death), necrosis of bone 1, septicemia 4 (4 deaths), wound infection 5 (1 death), other infections 12 (2 deaths), shock 14 (14 deaths), total 94 (54 deaths).

Suture of the bladder in cases of bladder wounds was recorded 21 times, with 11 deaths. The approach to the bladder was by the perineum 21 times, with 5 deaths; by the suprapubic route 10 times, with 3 deaths, and by the transperitoneal route 14 times, with 9 deaths. Enterorrhaphy was necessary in 3 cases, with 2 deaths, and resection of a part of the intestine in 2 cases, with 1 death. The removal of a foreign body was noted in 2 cases, with 1 death.

TRAUMATISM OF THE URETHRA

The urethra may be injured (1) by being *penetrated*: (*a*) from within by instruments, or (*b*) from without by projectiles or cutting objects; (2) by being *crushed* against the pubic bones in a fall or blow on the perineum; (3) by being *torn* by the displacement of the surrounding tissues in fracture of the pelvis or injuries of the penis, and (4) by being *burst* by internal pressure. In connection with fractures of the pelvis the urethra may also be directly lacerated by a fragment of bone. The bursting injuries seldom occur except when the wall of the urethra is greatly weakened by abscess or malignant growth, and usually above a stricture, so that their consideration comes more properly under the headings of inflammations and neoplasms of the urethra.

The commonest injuries are unfortunately those caused by the *penetration* of instruments. There is no excuse for the penetration of a normal urethra, but it is very difficult to avoid an occasional false passage in a pathologic urethra. The lesions especially likely to cause this accident are

urethral stricture, prostatic hypertrophy, and carcinoma. Less frequent conditions predisposing thereto are tuberculosis and urethral carcinoma. The tip of the instrument may leave the urethra at any point. False passages due to stricture are commonest in the bulbous urethra. They may pass posterior to the urethra for a variable distance, sometimes extending up on the posterior surface of the prostate, or anteriorly, in which case they may reach the prevesical space. In prostatic obstructions, the instrument may fail to enter the apex of the prostate, in which case it passes up anteriorly to the prevesical space, or if it impinges on a median lobe, it makes a passage in the substance of the prostate posterior to the urethra, which may extend through the trigone into the bladder or behind it. Sometimes the point of the instrument may re-enter the urethra higher up.

The effects of instrumental punctures of the urethra depend, first, on whether there is any obstruction distal to the puncture, and, second, on what tissues are reached by the false passage. Fortunately, the lesion is usually distal to the stricture or other obstruction, so that little pressure develops to cause extravasation of urine. If there is obstruction distal to the lesion, extravasation will occur. If erectile tissue (corpus spongiosum) or the preprostatic venous plexus be wounded, hematoma will develop. It is unusual for instruments to penetrate the rectum, but this may occur if they pass posterior to the prostate. Infection is the rule, as punctured urethras are usually infected. Abscess may develop along the track of the instrument, and may rupture into the urethra, rectum, bladder, or to the outside. Extravasation is usually followed by gangrene. If there is no obstruction below the puncture and if infection is slight, the false passage may heal without serious trouble, or it may become epithelialized and persist as a permanent channel. If there has been inflammation, stricture may occur later. False passages from the prostatic urethra to the bladder usually close, as they are surrounded by the elastic prostatic substance, but may be kept open by repeated instrumentation. The urethra is sometimes accidentally divided in operations for carcinoma of the rectum in males.

Gunshot wounds of the urethra may occur at any point and, like those of the bladder, may be simple penetrating wounds or lacerated wounds. The results are more serious if the urethra is completely divided, in which case voiding cannot occur and extravasation is inevitable unless large communication with the exterior exists. If the missile strikes a bone, the urethra may be injured by fragments. All degrees of injury may occur, up to tremendous losses of substance following wounds with large shell fragments, in which bones and soft tissues are included. Rectum and bladder may then both open into the gaping hole, and the condition of the patient is as distressing as could be imagined.

Crushing of the urethra against the lower surface of the pubic arch is a not uncommon accident, and is caused by a fall or blow on the perineum. The injury to the urethra may be in the nature of a bruise, without rupture of the mucosa, a longitudinal tear, or a transverse tear. Transverse tears may involve a part or all of the circumference. There may be in addition bruising and devitalization of varying portions of the two ends. If the tear does not extend all the way across the urethra, the edges are held near each other, and restitution may eventually take place. If it is complete, however, the two ends retract on account of the elasticity of the urethra, and may come to be separated by a considerable distance. In this class of cases the bulbous urethra is most frequently involved, though the

membranous urethra may be torn away from the bulb. Consequently, extravasation and hematoma which may occur are confined by the perineal fascia (Colles) unless this also is lacerated. The spread is then first along the perineum, then to the lower abdominal wall, avoiding the thighs, while later the penis and scrotum may be involved. If the triangular ligament is torn, the extravasation may extend into the periprostatic region, the ischiorectal fossæ, or the prevesical space.

The various sequelæ of extravasation may occur, as described above. In complete rupture—the commonest kind—the urine cannot escape through the distal urethra, and the urinary extravasation, driven by the full force of the bladder musculature, is rapid and extensive. Infection is the rule. Once the acute stage is past, the complication which is almost constant, and of great importance, is *stricture*. Probably owing to the depth of the infection which occurs, and the great extent of the fibrotic repair process, these strictures are much denser and firmer than gonorrheal strictures, they contract more rapidly, and are more difficult to dilate. If the ends of the urethra have not been properly approximated after the injury, the urine may pass through tortuous fibrotic channels, or entirely through fistulous tracts to the perineum or elsewhere on the outer surface.

The *penile urethra* may be ruptured, usually when the organ is erect, by blows or by other twisting or bending forces. These injuries will be further considered in the paragraphs on Traumatism of the Penis.

In *fractures of the pelvis* the urethra often escapes injury, but it may be torn across, or lacerated by bone fragments. The membranous urethra is the portion usually involved. The mechanism of these injuries is different from that of the ones caused by blows on the perineum, which are seldom severe enough to cause a bony fracture. When it does occur, it is usually a transverse break of the inferior pubic ramus, which has little effect on the injuries of the urinary tract. The commoner pelvic fractures result from crushing forces, like the wheels of wagons or automobiles, or the buffers of railway cars, acting from front to rear or from side to side. The fracture, therefore, oftenest of the pubes, is accompanied by displacement of the adjoining tissues, in the course of which the urethra is torn, and usually torn entirely across. It must be remembered, however, that this is only true of the severer injuries, and that the urethra escapes in the great majority of pelvic fractures. W. S. Baer[1] finds that the urethra is wounded in not over 1 or 2 per cent. of pelvic fractures. When it does happen, however, the consequences are serious and the damage may be extensive. The urethra may be lacerated for quite a distance, so that it is ultimately occluded by a wide and dense band of fibrous tissue. The prostate and bladder may also be lacerated, so that they too are involved in the fibrous change, and in addition a variety of false passages, including sometimes an entirely new channel from the bladder to the urethra or perineum, may be produced. Losses of substance may allow urethral diverticula and blind pockets to form. Lacerations of the corpora cavernosa, pudic nerves, ejaculatory ducts, and seminal vesicles may interfere with the sexual function, producing loss of erection or sterility, or both.

In the immediate complications, injury to the corpora cavernosa, pudic arteries, or preprostatic plexus may determine serious hemorrhage. Rarely the rectum may be involved, but in any case infection is almost inevitable. It occurs even in the absence of intervention, and is probably due to invasion by the bacteria which

[1] Personal communication.

frequently live harmlessly in the normal urethra. To these things urinary extravasation is added.

In the *diagnosis of injuries of the urethra* one must keep in mind the sort of traumatism in which it may occur, and search for it carefully. The principal symptoms are pain, hematuria, in the form of urethrorrhagia, and difficulty of urination. Typically the bleeding comes from the meatus and is independent of voiding. It may be lacking, however, when the injury is partial, with no break in the mucosa, or sometimes when the injury is proximal to the external sphincter, so that the blood remains in the posterior urethra or finds its way into the bladder. In the former case a local tumefaction (hematoma) along the urethra is present, and in the latter, the bladder may even be obstructed by clots. In some cases the patient may be able to void with little difficulty, in some he may be able with great

Fig. 611.—Cystogram of a case in which fracture of the pelvis had occurred some months previously. The displacement of the pubic bone can be seen. The urethra had been ruptured and there was a calculus in the dilated prostatic portion. Small contracted bladder. B. U. I. *x*-Ray 2734.

effort to emit a small quantity, and in others (the majority) he cannot void at all. There is usually not the tenesmus seen in injuries of the bladder, and not infrequently all signs of urinary extravasation are lacking at first. Indeed, the patient is sometimes able to state clearly that the perineal swelling came on just at the time when he first attempted to void after the accident. He really voids into his perineal tissues. With successive efforts the tumefaction grows. Its distribution depends on the location of the tear, as described above. It is studied by palpation of the perineum and abdomen, and by rectal examination. If a swelling can be felt by rectum, obscuring the prostate, the extravasation (urine or blood, or both) has reached above the triangular ligament. Distention of the bladder, determined by palpation or percussion, rules out rupture of that organ.

In many cases it will be found that, owing to the absence of voiding, someone

has attempted catheterization. This usually does no good and insures infection. Whenever there is any question of a rupture of the urethra all instrumentation should be avoided. If there is no injury to the urethra, catheterization is not necessary; if there is injury, there should be immediate operative exploration. Cases of urinary retention following bodily injuries with no lesion of the urinary tract may be confusing, but in the absence of positive signs of any such lesion, one may safely wait, since retentions of this sort eventually relieve themselves without harm to the patient. If there are doubtful signs, as perhaps slight hematuria or slight periurethral tumefaction, it is better to explore, since early operation may save life if there is injury, and does no harm if there is not.

According to statistics furnished by the Medical Department of the United States Army, 37 cases of wounds of the urethra were tabulated among 174,296 cases of battle wounds. Of these, 10 were caused by rifle balls, 4 by shell fragments, 4 by shrapnel, and in 19 the nature of the missile was not specified. Seven deaths occurred, a mortality of 18.9 per cent. Unfortunately, data are not as yet available as to the final outcome in the surviving cases, or as to the types of operation employed.

TRAUMATISM OF THE PENIS

Injuries to the penis are rare. They may be described as contusions, lacerations, ruptures, incised and punctured wounds, luxation, and strangulation. They are caused by blows, bending or twisting forces, pointed objects, cutting objects, projectiles, or constricting bands. In general, the seriousness of each depends (1) on whether the urethra is injured, and (2) on whether the erectile bodies are ruptured. Injuries of all sorts are more apt to occur when the organ is erect than when it is flaccid, and the hemorrhage is more severe. All penile lesions are apt to cause great edema of the loose areolar covering, which may lead to phimosis or paraphimosis.

In *contusions* the extent of the injury varies greatly. If it involves the corpora, with rupture of the tunica albuginea or sheath, we then speak of *rupture* of the penis. This is also sometimes spoken of as "fracture" of the penis, an inexact term. If there is an inflammatory change, as in acute urethritis, involving the corpus spongiosum, it may rupture much more easily than normally. Ignorant persons sometimes strike the penis purposely when in this condition, to "break the chordee." A favorite method is to allow a window sash to fall upon it. The injury may also occur during coitus, due to what Guyon called the "faux pas de cöit." *Lacerations* are due to projectiles, animal bites, etc.

Incised wounds are rare, and usually due to purposeful mutilation, either by assailants or by the patient himself if insane. *Punctured wounds* are still rarer. In *luxation*, or dislocation, the penis is squeezed in such a manner that the mucous membrane is torn around the coronary sulcus, and the body of the penis, with the glans attached, is pushed out of its sheath into the areolar tissue of the scrotum, lower abdomen, or thigh. Similar to this are the injuries in which the penis is partially or entirely denuded, the skin sometimes hanging inverted from the coronary sulcus. *Strangulation* is caused by strings, rubber bands, rings, etc., placed around the penis. A solid ring which slips easily over the flaccid penis may cause strangulation if erection occurs, followed by swelling which may prevent removal of the ring.

Gun-shot wounds may be perforating or lacerating, depending on the character of the projectile and its velocity.

All injuries of the penis are followed by edema. Injury of the corpora causes hemorrhage, which is more abundant if the penis is erect at the time of injury. Hemorrhage may, however, occur from an artery outside the erectile bodies. If there is a skin wound, hemorrhage is seldom sufficient to endanger life, but in a few cases is copious. The edema and hematoma may press upon the urethra sufficiently to cause difficult urination or retention. If the urethra is opened, extravasation of urine occurs, which infiltrates the subcutaneous tissue unless there is a wound of the skin with free communication to the outside. The infiltration is at first arrested at the root of the penis but later invades the perineum and abdominal wall. In luxation there will be urinary infiltration even if the urethra is uninjured. In cutting injuries and lacerations the distal part of the organ may be entirely severed, or remain hanging by a small tag. If replaced, restitution is often remarkable, and infection seldom serious. Both of these facts are supposedly due

FIG. 612.—Penis encircled by thick heavy steel ring (bushing) put on by "friends" during intoxication removed by means of a saw.

to the plentiful blood-supply. Following urinary extravasation, extensive superficial gangrene may occur, but this seldom involves the body of the penis. After the outer layers slough off a perfectly useful organ may remain.

In strangulation the picture differs according to whether the constricting band cuts off the entire blood-supply or only prevents the venous return. In the first case, a diffuse gangrene appears if the band remains in place long enough. It, of course, prevents urination also. In the second, the picture is quickly complicated by a tremendous edema, which buries the band and makes its removal very difficult. Voiding may be possible at first, with straining, but the edema soon causes complete obstruction. Later ecchymosis, and then gangrene occur, though after sloughing and sinus formation some small bits may retain their vitality, thanks to the arterial supply.

In an interesting case seen in the dispensary of our clinic, a heavy iron bushing ring, 3.5 x 0.8 cm., with a caliber of 2 cm., had been placed on the penis of a drunken

man. The penis was very edematous, but not gangrenous, and urination was possible, though difficult. The removal of this very heavy band was difficult, and was finally accomplished by means of an electric circular metal saw. Except for a little superficial ulceration in the area covered by the band, recovery was rapid and complete.

In other cases gold rings, bottles, hair, rubber bands, strings, etc., have served as strangulating agents.

In very few cases injuries to the main dorsal blood-vessels have caused dissecting hematoma (pathologic aneurysm) or arteriovenous fistula. Section of the dorsal vein may cause copious hemorrhage. Injuries to the frenum during coitus may tear the artery of the frenum, with marked hemorrhage.

The end-results depend on the extent of damage to the erectile bodies, either at the time of injury, or later by extravasation, sloughing, and infection. If any considerable portion of erectile tissue is replaced by scar tissue, there will be a lateral deformity, increased on erection, and sometimes making coitus impossible. Sometimes that portion of the corpus distal to the point of injury is incapable of becoming erect, though this difficulty may gradually ameliorate with the passage of time. After sloughing of the skin large granulomatous masses may develop unless proper skin grafting is done. With injury or sloughing of the urethra fistulæ may persist, and traumatic stricture occurs as in injuries of the deeper urethra.

The *symptoms* include usually great pain at the time that the injury is received, especially if the penis is erect, although in some cases of chordee, the process of "breaking" actually gives relief of pain. Edema comes on rather rapidly, and may give paraphimosis or inability to retract the prepuce. Hemorrhage from the corpora or an artery gives a very rapidly developing tumefaction, with discoloration of the skin. Extravasation of urine also causes swelling, which may be observed to increase during attempts to void. Difficult urination is frequent, but complete retention is rare unless the urethra is badly injured.

The *diagnosis* is usually obvious. The two points of importance to determine in subcutaneous injuries are whether the erectile bodies are injured, and whether there is rupture of the urethra. The first is indicated by a rapidly growing hematoma, with discoloration. This should be explored in any case, as if it is from an artery, this can be tied, while if it is from the erectile tissue, careful re-approximation is necessary to prevent ultimate deformity of the organ. Injury to the urethra is indicated by urethrorrhagia and the signs of extravasation. Edema may press upon the urethra distal to the tear and increase extravasation. Mere edema without localized tumor or bleeding from the urethra will probably subside under expectant treatment.

Luxation may give rise to a deceptive picture, the penile skin being so filled with blood-clot that it looks normal. Careful palpation will disclose the shaft and glans of the penis in their abnormal position and avoid errors. Strangulation also may deceive if the history is not obtained, since the constricting band is often concealed by the edema. In the absence of other cause for localized edema of the penis, this condition is to be suspected.

TRAUMATISM OF THE SCROTUM, SPERMATIC CORD, TESTICLE, AND ITS TUNICS

Scrotum.—The scrotum may be injured by contusions, lacerations, or penetrating wounds. Injuries involving the scrotum naturally not infrequently involve

the organs contained within it. These lesions, described farther on, must always be thought of as complications of scrotal injuries.

If the skin is unbroken, edema and effusion of blood may make it difficult to tell whether or not the scrotal contents have been damaged. The hematoma may be in the cavity of the tunica vaginalis, or in the subcutaneous tissues. The diagnostic points are discussed below.

Wounds of the scrotum not involving its contents are not of great consequence unless of wide extent, and may be expected to heal kindly if treated according to the proper surgical principles. Severe infection, while rare, may be a serious complication. Spreading in the very loose tissues of the scrotum, erysipelas, or thrombophlebitis with septicæmia may be caused. If the scrotal skin is widely torn, however, the picture may be complicated by herniation through the opening, especially if the tunica vaginalis has been opened, of the testis, epididymis, and part of the spermatic cord. These organs, if their blood-supply is intact, maintain their nutrition, but since the edge of the redundant scrotal skin always rolls under, there is little tendency to spontaneous reduction. In a few cases the testis has again become covered with skin by a long process of granulation from the surfaces of the wound and the serosa of the vaginal cavity.

Spermatic Cord.—The spermatic cord may be injured by blows, cuts, projectiles, or during surgical operations. All of these are rare; the last, however, depends on the skill of surgeons, and is, therefore, of especial interest.

Rupture of the pampiniform plexus gives rise to bleeding and a large hematoma. Unless all the vessels are broken, however, the nutrition of the testis will usually be maintained. The hemotoma will be subcutaneous unless the tunica vaginalis extends up the cord, when a hematocele may result.

In all injuries of the cord, the important question is whether the vas or the arterial supply of the testis have been interfered with. If the arterial supply is intact, section of the vas has no effect on the testis. The ends, however, retract, and unless reunited there is no chance of a re-establishment of the lumen and spermatozoa are no longer able to reach the vesicles from the affected testis. The spermatic artery is usually single. If it is divided, and the vas intact, the artery of the vas will prevent gangrene of the testis, but late atrophy is rather apt to occur. If both vas and spermatic artery are divided, the testis will undergo degeneration, unless a supernumerary spermatic artery be present. This is often in the form of an atrophy, apparently due to the existence of just enough collateral circulation from the surrounding tissues to prevent gangrene. Necrosis may, however, occur, since such anastomoses are often very slight. If too great a proportion of the veins of the pampiniform plexus are divided (as in varicocele operations), hydrocele is apt to occur. It is difficult to predict this accident, as it may come on after an operation in which several good sized veins are left, or fail to do so after another in which practically all the veins are divided. Late atrophy may also occur, but is much rarer. If both artery and veins of the cord are divided, the vas alone may be able to maintain the nutrition of the testis.

The operations in which surgical injury to the spermatic cord are most apt to occur are those for hernia, varicocele, hydrocele, and undescended testis. In herniotomy transplantation of the cord increases the likelihood of injury. Even if there is no injury at the time of operation, the cord may be constricted, with late hydrocele or testicular atrophy, by sewing up the ring too tightly. In orchid-

opexy it may be impossible to bring the testis into the scrotum without dividing the blood-supply to a dangerous extent, and if this is done we cannot rely on the artery of the vas deferens to maintain the nutrition of the testis except in a minority of cases. The vas, if undeveloped, or prolapsed, may be divided before it is identified. All these accidents may be avoided by careful surgery.

An especially interesting lesion which is usually associated with traumatism is *torsion of the spermatic cord.* There is a large literature on the subject, which will be found well summarized by Sebileau and Descomps.[1] Torsion of the cord can occur by either of two mechanisms. In the first, the entire testicular mass, including testis, epididymis, and tunics, rotates within the scrotum, so that the cord is twisted in its extravaginal portion. In order for this to occur, the loose areolar connections between the exterior surface of the tunica vaginalis and the scrotal tissues must be broken. The thickening at the lower pole of the epididymis—the region of the gubernaculum—is especially involved in this tearing process. This mechanism is especially apt to come into play in the case of undescended testes which are suddenly forced down, out of their former positions, by a blow or violent muscular contraction. This dislocation breaks the testicular mass free from the tissues surrounding it, and leaves it free to rotate. The rotation may result from the traumatic force itself, or apparently from strong and irregular contractions of the cremaster muscle. An analogous condition is that produced in animals by the procedure of "bistournage," which is substituted in some parts of the world for castration. The "bistourneur" manipulates the testis so that it, with the epididymis and tunica vaginalis, is broken loose from the subcutaneous tissues, and then rotates it three or four times. An artificial torsion is thus created, followed by swelling and later atrophy.

In the second mechanism the torsion is intravaginal. It is necessary in this type that an abnormally long and mobile "mesorchium" exist. Normally, the fact that the epididymis and testis are so closely applied to each other, and that the epididymis is attached to the scrotal parietes over at least four-fifths of its length, make intravaginal torsion entirely impossible. It is possible, (1) when the connections between the testis and epididymis are very loose and mobile, and (2) when the connections between the epididymis and the scrotal parieties are very loose and mobile. In extreme cases this is so marked that the testis and epididymis may hang in the vaginal cavity attached only by a pedicle the size of the little finger, and as much as 4 cm. long, containing the vas and the testicular vessels.[2]

Intravaginal torsions are much more frequent than extravaginal. Torsion is about as frequent in scrotal as in imperfectly descended testes, but since cryptorchids are so much in the minority in the general population, we must assume from this that they are more liable to torsion. Torsion may occur at any age, but is most frequent in early adult life. In cases of delayed descent of the testis torsion may occur at the time the organ leaves the inguinal canal.

In some cases the trauma necessary to produce torsion of the cord is very slight —some have even occurred during sleep. More often there is the history of some squeezing of the scrotum or of violent muscular effort.

By either of the above mechanisms, it will be seen that there is no chance of

[1] LeDentu and Delbet: Nouveau Traité de Chirurgie, 1916, xxxii, 606–629. (Maladies des Organes Génitaux de l'Homme.)

[2] Souligoux: Bulletin de la Société de Chirurgie, 1904.

any collateral circulation distal to the point of torsion. The twist effectively occludes the veins, but not the arteries. Everything below the twist is, therefore, turned into a hemorrhagic infarct, which is greatly distended and discolored. In extravaginal torsions the tunica vaginalis is involved in the infarct, while in intravaginal torsions it is unaffected except by the distention of the hemorrhagic effusion, which is constantly present in its cavity. The testis and epididymis soon become necrotic, as shown by the failure of various efforts to restore them by untwisting the cord, even as soon as an hour or two after it has occurred. If infection supervenes from the blood-stream, the infarct suppurates and discharges to the

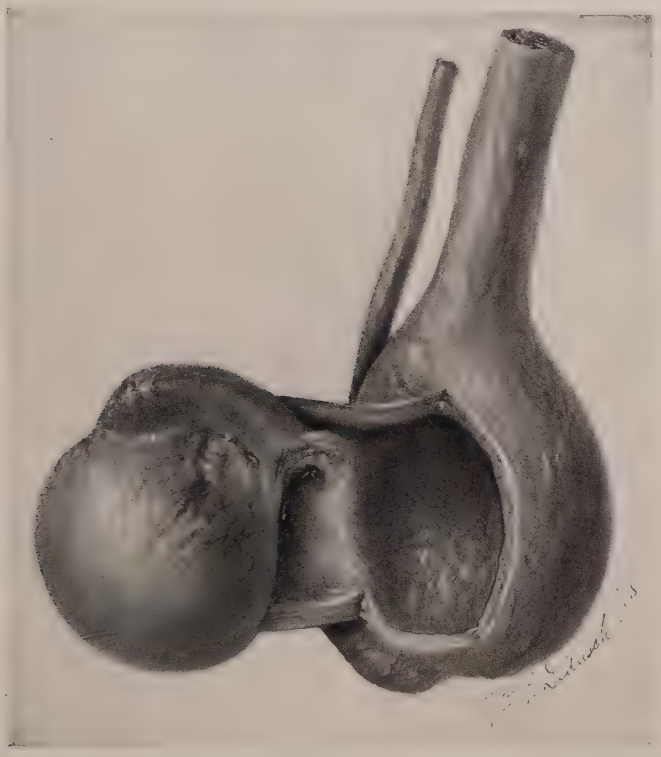


Fig. 613.—This patient was kicked in the scrotum twenty-two years before operation, swelling and pain having been present since. The tunica vaginalis was ¼ inch thick. Its contents were bloody fluid. The testis was connected with its inner wall by only a small pedicle, and was markedly degenerated. This is apparently the end-result of an old torsion of the testis and hematocele. B. U. I. 6690.

outside. If there is no infection, the exudate is eventually resorbed, the necrotic tissue replaced by scar, and complete fibrous atrophy finishes the process.

The *symptoms of torsion of the cord* are marked by the extreme suddenness of the onset, with severe, often sickening pain. The scrotum rapidly swells. This swelling is at first confined to the testicle, but later the scrotal tissues become edematous and the skin somewhat discolored. Constitutional symptoms are often lacking, but there may be prostration, abdominal distention, and vomiting. If infection occurs, there are fever and toxemia.

In the *diagnosis*, the picture is difficult to distinguish from acute epididymitis, in the case of a scrotal testis, or from strangulated hernia, in the case of an inguinal testis. The history, the absence of urethral discharge, and the very sudden onset

will help to rule out the former. In the latter case the history is valuable. If, previous to the onset, there has been an undescended testis, but no hernia, the diagnosis should be suspected, although epididymitis is not ruled out. In strangulated hernia the general and abdominal symptoms are usually more severe, but may be deficient. Exploration is the safest method. The diagnosis of torsion of the cord is often missed. Treatment is by orchidectomy.

Testicular Tunics.—The tunica vaginalis may be injured in wounds of the scrotum, as described above. The injuries of especial interest are those from puncture or surgical procedure, which are associated with an effusion of blood into the sac. This condition is known as *hematocele.* Occasionally there is spontaneous bleeding into a hydrocele.

The hemorrhage causing hematocele may be rapid or slow. In the case of hydrocele, where a vessel has been wounded during tapping, the blood is mixed with some hydrocele fluid. If the blood remains in the sac, it clots and undergoes organization so that the wall of the sac becomes very much thickened, or the cavity entirely obliterated. This organized clot is characterized by the presence of altered blood-pigment, much of it in phagocytes, and frequently there are crystals, probably of cholesterin, which may be surrounded by foreign body giant-cells. Calcification may occur. Except for the inconvenience it produces, hematocele is of little importance to the patient unless infected. Its importance lies in the fact that it is so difficult to distinguish from neoplasm and syphilis of the testis, and certain cases of hydrocele and tuberculosis.

Hemorrhage may also occur outside the tunica vaginalis. This is sometimes called extravaginal hematocele, but is better spoken of as *hematoma.* Scrotal hematoma may be localized at any point, or may spread up around the cord, and can coexist with true hematocele.

Hematocele is firm, rounded, heavy, non-translucent, and usually not painful. In all of these particulars it resembles neoplasm and syphilis. The Wassermann reaction and therapeutic test help to rule out syphilis. The history of a paracentesis during which blood was obtained does not rule out neoplasm, as the hydrocele accompanying neoplasm is sometimes tapped by undiscriminating physicians. Exploration is often the only safe method. Fortunately hematocele is rare. Scrotal hematoma is unfortunately only too common after surgical operations upon the contents of the scrotum and inguinal canal.

Hematocele following operation with insufficient hemostasis is usually associated with some extravaginal hematoma as well. It is apt to become infected.

Testis.—The testis may suffer contusion, perforation, laceration, incision, rupture, or luxation. We have also listed under traumatism the damage occurring from radiation (radium, *x*-rays).

In simple *contusion* small vessels are ruptured, but while there may be multiple hemorrhagic points, hemorrhage is never great as it is arrested by internal pressure when the tunica albuginea is intact. There may be edema as well, and the testis becomes somewhat enlarged and firm. The end-results may be more serious, however, as fibrosis occurs at each focus of injury. If these are numerous and widespread enough, cicatricial contraction may occur, with eventual atrophy of the testis. In such a case the spermatogenic function is arrested, but some interstitial

cells may persist. Suppuration may occur, but this is often due to a pre-existent but unsuspected tuberculosis. It should be remembered that patients often attribute to a blow various lesions, such as tuberculosis, neoplasm, and syphilis, when the blow has really only served to call their attention to the lesion for the first time.

Perforating, lacerated, and *incised wounds* all depend for their results on the size of the opening made in the tunica albuginea. Following any such opening, the soft testicular substance tends to evert through the wound. If the wound is large, this eversion is progressive and the testis is practically turned inside out, a condition which results in loss of the organ. If the wound is small, healing processes close it before any important portion of the testicular substance has been extruded. When there is extensive extrusion of the testicular substance, it appears on the surface and is known as a "fungus." The projecting mass is practically certain to be infected, and this infection may spread to the interior of the testis, causing suppuration and destruction of the remaining portion of the testis.

The testis may be *ruptured* by a crushing force, though this accident is rare on account of the ease with which the freely movable testis escapes from blows and other injuries. The defects in the tunica albuginea are usually quite large after this type of accident, and the testicular tubules escape as described above, but with the difference that, when the skin is not torn, the fungus is not on the outside, but within the cavity of the tunica vaginalis. There is often an associated hematocele. The circulatory disturbance is so great that atrophy is to be expected as the result of this condition.

When the tunica albuginea is *cut* by accident or design during surgical operations, no harm results if the defect is closed at once. In other cases fungus may result. This accident is especially to be avoided in the operation of epididymotomy through a very small incision for acute epididymitis. We have seen such a case in which a small cut was made in the testis by mistake, to be followed by a small fungus which was progressive, and by means of which the entire substance of the testis was eventually extruded before healing took place.

All wounds involving the substance of the testis are incomparably more serious if bilateral; not as concerns the life of the patient, but as concerns his subsequent well being. Sterility alone may have serious mental effects. When loss of the interstitial tissue also occurs the results are the same as after double castration.

Luxation of the testis is produced by a force which squeezes the organ out of its scrotal bed to a new position. This injury is very rare. The testis may then lie in the perineum, under the skin of the lower abdomen, thigh, or penis, or may be pushed up into the inguinal canal or even into the abdomen. The diagnosis is simple unless the organ has disappeared into the abdomen.

Much has been written concerning *orchitis by effort,* in which it was supposed that an infectious process was precipitated by some traumatism to the testis, resulting from a violent muscular strain. Modern authorities are of the belief that no such group of cases exists, and that they are really examples of (1) pre-existent testicular lesions to which attention has first been called by a trauma, or (2) cases in which the trauma has favored the localization in the testicle of an infection originating in the urethra, prostate, vesicles, or, rarely, coming from the blood-

stream. There can be little doubt that traumatism to the epididymis during urethritis favors the development of epididymitis.

When the testis is subjected to prolonged action of *x-rays*, a degeneration of the spermatogenic elements occurs,[1] commencing with the least differentiated cells (spermatogonia and spermatocytes). Therefore, cycles already under way at the beginning of the exposure are completed, and sterility appears slowly, but is eventually complete. The tubules are lined with Sertoli cells and a few undifferentiated germ cells. Ordinarily, the interstitial cells are not affected, but if the exposure is very prolonged, they too may succumb, and the testicle undergo fibrous atrophy. If the exposure has not been too long continued, its cessation is followed by a very slow return of the spermatogenic function to normal. *Radium* emanations are also capable of causing sterility in a similar manner.

Of late years the claim has been made by Steinach[2] that, following partial destruction of the spermatogenic apparatus by means of the *x*-ray, there was a regenerative process in the testis marked especially by hyperplasia of the interstitial cells. Analogy was made between this hyperplasia and that which occurs in cryptorchid testes where there is no spermatogenesis, and it was proposed to take advantage of it to increase the endocrine function of the testis in old men and bring about rejuvenation. The hypothesis has been extended to women, in whom rejuvenation is said also to occur after radiation of the ovaries. No satisfactory proof of this hypothesis has been adduced, and we believe that all similar claims should be regarded with the greatest reserve until such proof is adduced. The same may be said of the efforts to cause rejuvenation by ligation or resection of the vas deferens.

According to the available statistics, wounds of the genital organs comprised 0.47 per cent. of the total tabulated battle casualities in the Civil War, and 0.43 per cent. in the United States Army in the World War. Details are shown in the following table:

TABLE 150

	Total battle casualties.	Wounds, genital organs.	Total deaths from wounds.	Deaths after genital wounds.	Percentage of deaths after genital wounds.
Civil War.....	233,884	1149	31,922	144	12.5
World War....	170,841	798	15,815	69	8.65

The following table shows the location of wounds of the genitalia in the United States Army in the World War, the type of projectile causing the injury, and the fatal results, as furnished by the statistical office of the Medical Department of the United States Army:

[1] Simmonds: Fortschritte aus der Gebiet der Röntgenstrahlen, 1909, xiv, 229–238. Nogier and Regaud: Comptes Rendus de l'Academie des Sciences (Paris), 1909, cxlix, 1398–1401; Comptes Rendus de la Société de Biologie, 1911, lxx, 50–52. Bergoine and Tribondeau: Comptes Rendus de la Société de Biologie, 1904, lvii, 400–402, 592–595; 1905, lviii, 154, 155, 155–158, 282–284, 678–680, 1029–1031.

[2] See the above references, and also Hewer: Journal of Physiology, 1916, i, 434–458. Shattock and Seligmand: British Medical Journal, 1904, ii (Suppl.), 11. Steinach: Archiv der Entwicklungsmechanik der Organen, 1920, xlvi, 553–619. An excellent critical and literary review will be found in Thorek, The Human Testis, Philadelphia, 1924.

TABLE 151

Wounds of the Genital Organs, 1917–18

	Admissions.					Deaths.					Percentage of deaths.				
	Rifle ball.	Shell.	Shrapnel.	Not specified.	Total.	Rifle ball.	Shell.	Shrapnel.	Not specified.	Total.	Rifle ball.	Shell.	Shrapnel.	Not specified.	Total.
Penis	21	17	45	63	146	...	1	1	8	10	...	5.9	2.2	12.7	6.85
Perineum	9	10	13	17	49	2	1	...	3	6	22.2	10.0	...	17.6	12.24
Scrotum	65	40	61	170	336	2	6	4	17	29	3.1	15.0	6.6	10.0	8.63
Testis	28	41	49	112	230	2	2	5	8	17	7.1	4.9	10.2	7.1	7.39
Total genital wounds	123	108	168	362	761	6	10	10	36	62					
Total, all wounds	23,625	20,506	39,979	90,186	174,296	1167	1876	2315	8111	13,469	4.9	9.1	5.8	9.0	7.73

The wounds of the genitalia are seen to be much less dangerous to life than those of the urinary organs. No data are as yet available as to the number suffering permanent impairment of the sexual functions.

FOREIGN BODIES IN THE UROGENITAL TRACT

Foreign bodies are of little importance except in the bladder and urethra.

Kidney.—In the kidney region the only foreign bodies found are projectiles or other objects which have entered through wounds, including rubber tubes, gauze, silk sutures, etc., left at the time of operation. Calculi which have left the kidney pelvis may act as foreign bodies in the perinephric region. Bullets or shell fragments rarely come to rest in the kidney without causing severe lesions at the time. They may determine infection and abscess, become encysted, or get into the pelvis or calyces, where they usually form the nuclei of stones.

In general, foreign bodies are associated sooner or later with infection and we see them causing chronically suppurating sinuses, perinephric abscess, or pyelonephritis. In the pelvis obstruction and hydronephrosis or pyonephrosis may be produced. The depth and size of operative wounds of the kidney make it easy to lose pieces of gauze therein. Intractable suppuration of such a wound without obvious cause should suggest this accident. If there is a urinary fistula, the gauze may become infiltrated with calcareous material. It will then be visible in the *x*-ray. Associated with wounds there may be, besides the projectile or wounding object itself, earth, rock fragments, clothing, buttons, etc. This sort of thing can be treated properly only by early and thorough "débridement" with the scalpel.

Foreign bodies are rare in the *ureter*. A projectile, piece of gauze, etc., in the neighborhood of the ureter may set up an inflammatory reaction in which the ureter becomes involved and strictured. It is extremely rare for ureteral catheters to break in the ureter; if one did so it would probably be expelled. Silk sutures used in the adventitia of the ureter may migrate to its interior and become encrusted, and for this reason catgut only should be used in ureteral repairs. Cabot[1] mentions a case in which a long straw passed in through the urethra had become engaged in one of the ureters for a part of its length.

Bladder.—Foreign bodies of all descriptions are found in the bladder. It would be useless to attempt a list of all the objects which have found their way there, but by classifying them in various ways we may obtain an idea of what they may be, and how their nature may affect the clinical picture. Thus they may be divided in the following several ways:

A. According to specific gravity.
   1. Those which float in urine.
      Examples: Wax, paraffin, wood, rubber tubing containing air.
   2. Those which sink in urine.
      Examples: Metal fragments, bone, rubber, gauze.

B. According to shape, size, and consistence.
   1. Flexible, soft, or small.
      Examples: Filiform, chewing gum, shot, wax, rubber, gauze.
   2. Long, but friable or pliable.
      Examples: Glass tubing, hairpins.
   3. Long or large, and resistant.
      Examples: Metal instruments, pencils, etc.

C. According to solubility.
   1. Soluble.
      Examples: Beeswax, paraffin, etc.
   2. Insoluble.
      Examples: Everything except the above.

[1] Cabot's Modern Urology, 1924, ii, 193–196.

D. According to opacity to the *x*-ray.
   1. Translucent.
      Examples: Gauze, wax, gum, wood, celluloid, very fine objects as filiform (without metal end).
   2. Opaque.
      Examples: Metal, rubber, any of above when encrusted with calcareous matter.

E. According to manner of introduction.
   1. By pre-existent passages.
      (*a*) Urethra.
         1. By accident during diagnostic or therapeutic procedures.
            Examples: Catheter, filiform, beak of lithotrite.
         2. For erotic reasons.
            Examples are endless.
         3. By own motility.
            Examples: Fly and beetle larvæ.
      (*b*) Fistulæ, suprapubic, vesicovaginal, or perineal.
         1. By accident during diagnostic or therapeutic procedures.
            Examples: Catheter, gauze, rubber tubing.
         2. By own motility.
            Examples: Fly and beetle larvæ.
   2. Through wounds.
      (*a*) Traumatic.
         Examples: Projectiles, pieces of wood, clothing.
      (*b*) Surgical.
         Examples: Gauze, rubber tubing, instruments, detached pieces of tissue, silk or wire sutures.
   3. By migration.
      (*a*) From other wounds.
         Examples: Gauze, projectiles, instruments, sutures.
      (*b*) From other lesions.
         Examples: Fecolith from appendix abscess, pieces of bone from fractured pelvis.
   4. Through enterovesical fistulæ.
      Examples: Enteroliths, scybala.

In addition, certain materials foreign to the bladder occasionally find their way there, but are not ordinarily considered with foreign bodies, namely, débris from dermoid cysts and hydatid (echinococcus) material.

The *specific gravity* is of interest from a diagnostic viewpoint, that is, we must look not only in the base of the bladder but also at its highest point. *Shape, size,* and *consistence* determine the means by which removal will be attempted, and the ease or difficulty with which it will be accomplished. The *solubility* is important, as large masses of a material which will be dissolved in any fluid that can safely be put in the bladder may be removed without operation. *Opacity* to the *x*-ray is a great help in diagnosis, enabling us to determine the size, shape, and position of the object, but it must be remembered that certain foreign bodies are invisible in roentgenograms. The history of the *manner of introduction* enables us to suspect the presence of a foreign body and to guess at its size and shape, if they are not already known. In addition, the mental state which has led a patient to insert objects in his bladder sometimes enables us to predict that he will continue to repeat the process indefinitely.

By far the greater number of foreign bodies are *introduced through the urethra.* Of those put in for *erotic reasons,* most occur in early adult life, and the female sex preponderates greatly. Of those left in *accidentally,* most occur in the later years

of life, when urinary affections are commonest, and the male sex preponderates greatly.

Foreign bodies in the bladder are almost always accompanied by infection sooner or later, usually carrying it with them. Occasionally a projectile arriving by migration through the tissues may remain in the bladder for some time without infection. Cystitis aggravates the symptoms greatly, and is not infrequently complicated by pyelonephritis. All foreign bodies become encrusted with calcareous material and become eventually the nuclei of stones (Fig. 614) except pieces of pure, clean wax. This is because the surface tension of paraffin is practically the same as that of urine. If a piece of paraffin or other wax has dirt or dust on its surface,

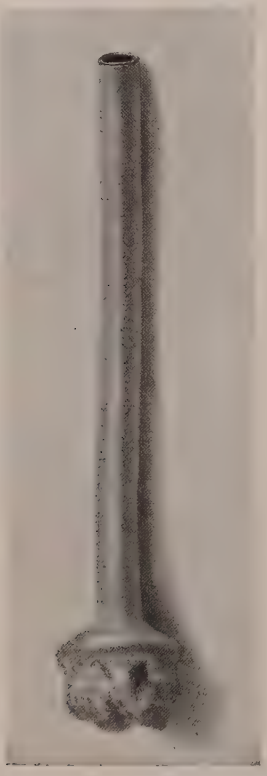


Fig. 614.—Calculus formed on end of mushroom catheter which was allowed to remain several weeks in suprapubic wound. Diagnosis made by cystoscope, perineal prostatectomy performed, mushroom catheter and stone removed with stone forceps through perineal wound. B. U. I. 7174.

or contains a piece of wick or string, it too will become encrusted. It is stated that smooth pieces of silver are less likely to become encrusted than any other metal. Phosphatic encrustation is the rule, since the cystitis is often alkaline. In uninfected bladders or acid cystitis uratic deposits may occur. A long object may be encrusted over only a part of its length, usually the middle part. Apparently the contractions of the bladder rub the deposits off the ends of the object. The rapidity of encrustation varies greatly, depending on the nature of the foreign body, the composition of the urine, and the kind of cystitis present. It may be extremely rapid.

Pieces of detached tissue left in the bladder, for example, prostatic lobes, usu-

ally do not undergo putrefaction, but become softened by autolytic processes while retaining their form. They serve, however, as an excellent culture-medium for the bacteria of cystitis. (The ordinary bacteria, of the colon and staphylococcus groups, are not proteolytic.) They may become infiltrated or coated with calcareous material.

Ulceration and injury of the bladder wall occur more frequently than with calculi, on account of the size and irregularity of many of the foreign bodies. It is remarkable, however, how often sharp-pointed objects, as for example, hairpins, fail to penetrate the bladder wall. If perforation does occur, there may be perivesical inflammation with abscess or fistula formation. Occasionally the foreign body leaves the bladder through the opening thus created, and may be discharged through a fistula to the rectum, sigmoid, vagina, or skin surface. In other cases one end of the foreign body becomes embedded and fixed in the bladder wall. If the peritoneal aspect of the bladder is penetrated—a rare occurrence—peritonitis may be set up or the object be walled off by adherent intestine and omentum.

Large foreign bodies or smooth, round ones may obstruct the vesical orifice and cause difficulty of urination or retention. Occasionally a foreign body finds its way into a diverticulum, in which it may escape observation. Spontaneous expulsion is not the rule, but sometimes occurs with surprisingly large or long objects. It is more frequent in the female. The male may expel long objects if by a happy chance one end enters the urethral orifice. Objects may be expelled after remaining in the bladder a long time; up to thirteen months.[1]

The *symptoms of foreign body* are in general similar to those of vesical calculus (*q. v.*). With a smooth object, and only slight cystitis, the symptoms may be minimal. In the case of those who have themselves inserted the objects, there is in addition a great disinclination to seek aid, thereby disclosing a condition of which they are ashamed, until the symptoms become very distressing. These usually consist especially of painful and frequent urination. Infection gives pyuria, and hematuria, often absent, depends on the nature of the object (sharp, pointed, jagged) and on the degree of the cystitis. The onset of pyelonephritis gives fever, pain in the kidney region, etc., and as kidney damage increases, the symptoms of uremia supervene. When something has been left in the bladder at cystotomy, the fistula usually refuses to close. If there is encrustation sand or gravel may be passed.

The *diagnosis of foreign body* in the bladder is usually a simple matter, with the aid of the cystoscope, when the history gives a clue as to the probable existence of the condition. The difficult cases are those in which the presence of the foreign object is unsuspected, or in which intense pyuria and contracture of the bladder make cystoscopic examination difficult or impossible. In these cases the *x*-ray may be of assistance, with the reservations mentioned above. The modern urologist relies so greatly on the cystoscope that an examination will usually be done to try to elucidate symptoms due to unsuspected foreign body, when it will be discovered.

We have, however, seen a case in which a gauze sponge left in the bladder at the time of cystotomy was missed at three successive cystoscopic examinations (B. U. I. 10,362). This was because, pyelonephritis having developed, and the patient being in poor condition, the cystoscopist endeavored to catheterize the ureters as quickly as possible, and so neglected to examine the vault of the bladder

[1] Minet: Encyclopædie Françiase d'Urologie, 1921, iv, 369–392.

This indicates the importance of a careful and thorough inspection whenever cystoscopy is done. In another case (B. U. I. 10,492) with persistent fistula there were found in the bladder at operation three partially autolyzed prostatic lobes, one quite large, a piece of gauze 4 feet long, and a large collection of calcareous particles, all the result of a previously attempted suprapubic prostatectomy. In a third case (B. U. I. 6,413) suprapubic prostatectomy gave an excellent result except that the stream was sometimes interrupted during voiding. Cystoscopy showed a small mass of detached mucosa or inspissated blood-clot, which had acted as a ball valve. It was easily removed through the cystoscope, and proved to have about the consistence of chewing gum. Relief was complete.

Treatment.—The instrumental and operative removal of foreign bodies is considered in Chapter XVI.

Pieces of paraffin or other wax in the bladder may be removed by dissolving them in some fat-solvent liquid. For this purpose xylol, gasolene, and kerosene, or various mixtures of these have been recommended. About 50 c.c. is injected and retained. It may take some time to dissolve the mass, so that the solvent must be replaced in the bladder after each voiding, or the patient, if he is able, refrains from emptying his bladder completely. If this is possible, the solvent remains in the upper part of the bladder on account of its low specific gravity, and is not lost. It must, of course, be renewed from time to time in any case, as it becomes saturated with wax. The result must be controlled by cystoscopy. This is the ideal method for this type of foreign body.

A study of the records of the Brady Institute shows 22 cases of foreign bodies removed from the bladder. Of these patients, 9 came in with filiforms in the bladder. Most of the filiforms were of the type which screw to dilating followers and had been broken at the point of junction during urethral dilations. The foreign body in 5 of these was removed with our cystoscopic rongeur, in 2 with a lithotrite, and in 1 by suprapubic cystotomy.

The cystoscopic rongeur is the most satisfactory instrument for removal of filiforms. It is simply necessary to locate the filiform with the cystoscope, bring it into the center of the field, rotate the rongeur forceps, and grasp the filiform, preferably at one end, although owing to the flexible character of the filiform it is possible to remove it when caught elsewhere.

In the absence of the cystoscopic rongeur a lithotrite is quite a satisfactory instrument. In the use of the lithotrite the bladder is partly filled with fluid, the instrument introduced and opened out and then closed. If the filiform is entrapped between the blades, it will be noted externally that the blades are not fully approximated. Fixing the clutch and adding a little more pressure to the blades the filiform is thus firmly grasped and drawn out with the instrument. It is often necessary to grapple in various positions until the filiform is caught. In so doing the mucous membrane of the bladder may be picked up and it is, therefore, advisable before screwing the blades home to be sure that the mucous membrane is not between them by rotating the instrument gently and bringing the blades to a position in the center of the bladder with the beak directed upward.

In 1 case the filiform was removed by suprapubic operation. A prostatic bar and a suprapubic fistula were present. The fistula was excised and a punch operation carried out at the same time that the filiform was removed.

In one case the foreign body consisted of the male blade of a lithotrite. B. U. I. 3039, C. F. G., aged eighty-one, admitted December 9, 1911. Cystoscopy showed a fibrous prostate with a median bar and slight lateral enlargement and a very large calculus in the bladder. Litholapaxy was attempted and an evacuating cystoscopic lithotrite introduced. A stone 1 inch in diameter was caught, the instrument screwed down upon it. Almost immediately the operator had the sensation of something giving away, so the instrument was immediately withdrawn and it was found that the male blade had broken off and remained in the bladder. Examination showed that this fragment measured about 3 cm. in length and from 5 to 7 mm. in width. It had the typical teeth barb of the usual Bigelow design. As the vesical fluid was bloody it seemed advisable to delay removal of the fragment with the cystoscopic rongeur. It was decided, however, to carry out a punch operation to remove the median prostatic bar and thus facilitate the remaining operations for removal of fragment and calculus. A punch operation was then carried out, four cuts being made—one posterior, one right, one left, and a fourth posteriorly again. Two days later a second operation was performed. A catheter was passed, bladder filled with clear fluid, cystoscopic rongeur introduced, and an excellent view of the base of the bladder obtained. Three

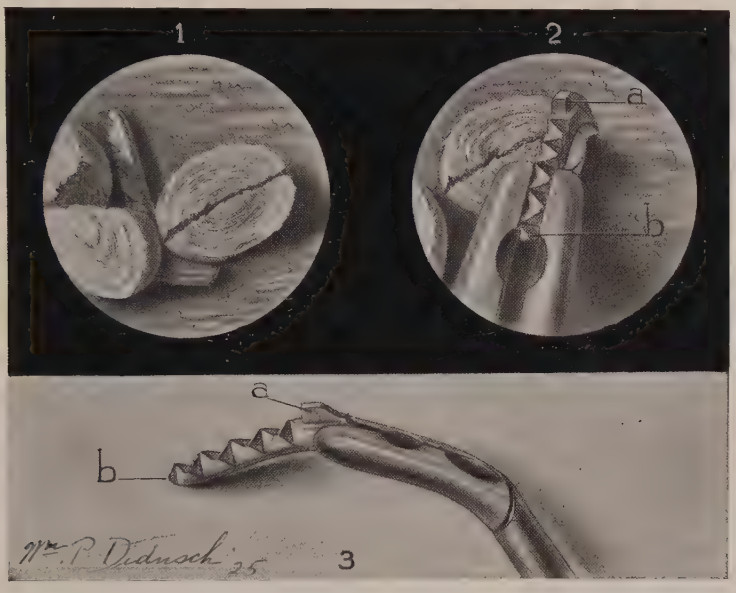


Fig. 615.—A case of vesical calculus in which lithotrity was attempted, male blade of lithotrite broke off and remained in bladder: 1. Cystoscopic view obtained showing blade among stone fragments. 2. Cystoscopic view of blade picked up by Young's cystoscopic rongeur. Inspection showed that it was caught by the wrong end and barb would prevent removal. 3. It was then turned loose and finally grasped by the proper end, *a*, and drawn through urethra without injury. B. U. I. 3039.

large fragments of stone were seen and between them, lying in the base of the bladder, could be seen the broken blade of the lithotrite (Fig. 615, 1). With the beak of the rongeur the fragments were pushed aside and the lithotrite blade picked up and carried to the middle of the bladder. Inspection showed that it was grasped by the outer end (Fig. 615, 2) and that it would be impossible to remove it on account of the barbs on its posterior surface. It was, therefore, dropped back into the bladder. The blade was then grasped properly at its fractured end so that it could be extracted (Fig. 615, 3). Cystoscopic inspection showing that everything was propitious, the instrument was turned so that the beak and fragment projected upward. The cystoscope was drawn into the sheath and the lithotrite pulled out of the bladder without difficulty and with very little traumatism, and much to our relief. Another lithotrite was then introduced and the stone crushed and completely removed at one sitting.

The *foreign body was surrounded by a calculus* in 5 cases. B. U. I. 2146, H. V., aged fifty-five, came in complaining of vesical irritation. Six months previously a right inguinal herniotomy had been performed, during which the bladder was injured and closed with sutures. The cystoscope showed a small, irregular, ovoid calculus suspended from the right anterior wall of

the bladder by a thread. Tapping the abdominal wall caused the stone to swing like a pendulum. The cystoscopic rongeur was introduced and most of the stone was removed in one piece. At subsequent operations three other stones and four silk stitches were removed from the bladder with the cystoscopic rongeur, after which the patient made a satisfactory recovery.

In another case, B. U. I. 8808, J. M. C., aged forty, complained of a perineal urinary fistula. A probe showed that this passed through the anterior wall of the bladder. The cystoscope showed a slender calculus hanging from the anterior wall of the bladder by a hair (Fig. 373). This was grasped with the cystoscope and easily removed. Subsequently the patient passed several calculi, each attached to a hair. Suprapubic operation was carried out and a dermoid cyst discovered along the anterior wall of the bladder, which was excised, after which no more hairs or calculi were passed.

B. U. I. 7674, J. H. L., aged sixty-two years. Had a previous suprapubic operation for drainage in which a de Pezzer catheter had been allowed to remain for several weeks. On cystoscopic examination the mushroom intravesical end of the catheter was found completely covered with a large calculus (Fig. 614). It was removed through the perineum after the hypertrophied prostate had been enucleated. The patient made an excellent recovery.

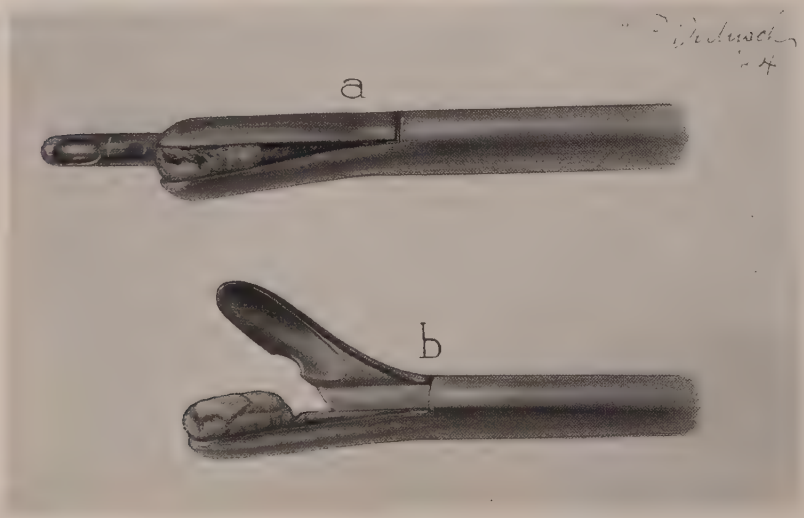


Fig. 616.—Vesical calculus with large nucleus of paraffin sufficiently light to make it float. Removal with cystoscopic rongeur: *a*, Calculus caught with blades in bladder; *b*, after removal. B. U. I. 12,787.

Another case, B. U. I. 12,787, a boy aged nineteen, came in complaining of marked frequency of urination of five years' duration. The cystoscope showed a marked edema of the trigone. The cause could not be detected until the cystoscope was turned upward when, to our amazement, we saw what appeared to be a calculus floating in the fluid, next to the air-bubble, near the vertex of the bladder. On questioning, the patient admitted that five years before he had lost a slender pencil of paraffin in the urethra (urethral masturbation). He thought it had slipped into his bladder, but said nothing about it. In a short time he began to have bladder irritation. By means of our cystoscopic rongeur the calculus was easily grasped and removed. Inspection showed that it measured about 6 x 8 x 12 mm. in size. The mass was composed largely of semitranslucent paraffin, the surface of which was covered for the most part with a thin layer of grayish white urinary salts, the weight of which was not sufficient to make the foreign body sink. As far as we know, this is the first case of floating calculus to be reported.

B. U. I. 3528 was a similar case in which the calculus grew to huge dimensions. D. H. I., aged nineteen, admitted April 15, 1923. Patient admitted that several years before while employing a pencil of paraffin within the urethra it slipped away from him and disappeared into the bladder. Shortly after that he began to have frequency of urination which became pronounced

two years ago. Since then frequency, difficulty, and pain gradually became worse and on admission he was voiding urine every half-hour, night and day, and had a dull, aching pain in the bladder. On examination with the cystoscope a very large calculus was found in the bladder. A few days later we removed it by suprapubic cystotomy. It measured 1 x 2.5 x 3.5 inches in size, was rough, grayish white, and fairly soft. In view of the history it was immediately divided with a saw and curled up in the center was found a mass of paraffin, which measured roughly about 1 x 2 cm. in size (Fig. 617). The trigone was greatly hypertrophied and the bladder was virtually divided into two halves, in the anterior half of which the calculus lay.

A similar case was B. U. I. 10,419, T. C. O., aged twenty-one, admitted April 5, 1922. Patient stated that five days previously he had fashioned a pencil from a portion of wax candle and passed it into the urethra. It broke off during manipulation and escaped into the bladder. Since then he had been having difficulty on urination and irritation. When voiding the urinary stream was suddenly stopped. This was accompanied by severe pain and followed by bleeding. The cystoscopic rongeur was introduced and a fairly large, irregular mass of paraffin seen floating in the vesical fluid. It was grasped with the cystoscopic rongeur and removed in numerous small pieces. Subsequent cystoscopic examination was negative.

Fig. 617.—Large calculus, surrounding mass of paraffin which had been introduced into urethra for masturbation, and slipped into bladder. B. U. I. 3528.

B. U. I. 4497, R. H. B., aged nineteen, admitted July 26, 1915, complaining of a twig of asparagus in the urethra and bladder. This had been introduced four days previously and a portion had broken off and remained in the urethra. He consulted a physician who carried out cystoscopy and was able to remove a portion about 3 inches in length. Attempts to remove the rest of the asparagus did not succeed. The cystoscopic rongeur was introduced without difficulty and two small pieces of asparagus were located behind the trigone and easily removed without injury to the bladder.

An equally extraordinary case was that of a young man who arrived at the hospital many years ago with a history of having injected warm beef gravy forcibly into the urethra in considerable quantity. He was amazed a little later to find he was unable to void urine and subsequently had complete retention for which he was brought into the hospital. Catheterization was impossible and suprapubic cystostomy was carried out. A large mass of tallow-like material was found in the bladder and removed. It was evident that when the fluid injected became cool it congealed and formed a mass which could not be voided through the urethra. It has been suggested that many of the objects called in the literature urostealiths or "fatty stones" really reached the bladder in this manner.

As previously pointed out, the literature contains a great array of amazing articles that have been introduced by patients into the urethra. Many of these are of a character necessarily so difficult or painful to introduce that one is astonished not only that it should have been attempted but that the patient should have succeeded in passing it through the urethra into the bladder.

The following case in which a needle was found in the bladder is different, in that the patient swallowed the needle seven years previously. A young woman aged thirty-five came in complaining of frequency of urination and pain. Introducing the cystoscope we found a needle projecting into the bladder through the posterior bladder wall. Introducing a slender straight clamp through the urethra by the side of the cystoscope, the needle was grasped and extracted without difficulty and she made a satisfactory convalescence. Patient was accompanied by a sister who corroborated the following history which she gave: Seven years previously while engaged in sewing she placed a needle in her mouth while she looked for a new spool of thread. Her sister made some amusing remark and the patient laughed and swallowed the needle. For a time thereafter she suffered considerably with pain, nausea, vomiting, etc. The stomach symptoms eventually disappeared, but occasionally she would have severe pain in the abdomen. This gradually traveled downward and for a time was associated with severe pain in the pelvis. Recently, irritability of the bladder, frequency of urination, and pain had been constantly present and for this she sought relief. The needle was considerably rusted, but had a sharp point and had evidently traveled slowly during the period of seven years through the abdominal viscera and finally entered the bladder.

Urethra.—Foreign bodies in the urethra are of the same types as those described for the bladder. They may be objects originally in the bladder, which have entered the urethra and become arrested in it, or they may have been introduced from the exterior. Objects which are not too large or too irregular tend to be expelled after they have entered the urethra from the bladder, as a result apparently of the pressure of the urine behind them. On the other hand, objects inserted through the meatus and released tend to advance toward the bladder, and often reach it. The explanation of this progress against the stream of urine is not yet entirely clear. Various hypotheses have been advanced, of which the most likely are those involving only the movements imparted to the urethra during efforts to recover the object, and those occurring with erection and detumescence. The maneuvers naturally adopted would involve, first, pulling on the penis, which would tend to stretch the urethra over the object, and, second, pushing on it in an effort to bring the lips of the meatus over the object so that it could be seized, which would have the undesired effect of pushing it farther into the urethra. If the object is arrested in the urethra, it is most likely to be in the bulbous region, with the constriction of the external sphincter above and that of the pendulous urethra below. The point of arrest is also sometimes in the fossa navicularis, which is fusiform, in the penile urethra, and rarely in the membranous or prostatic portions. Objects are more likely to be arrested in the prostatic portion when it is deformed or dilated, as in prostatic hypertrophy. Objects coming from the bladder may be arrested behind a stricture. Arrest is much less common in the female than in the male, the objects usually being expelled or passing into the bladder.

The *shape* of urethral foreign bodies is somewhat more restricted than in the case of those of the bladder, since the cavity is smaller, but in general they are very similar since most vesical foreign bodies have arrived through the urethra. Objects with central constriction may remain with the external or internal sphincter in the constriction. Long and rigid objects may reach all the way across the bladder

and be unable to enter it entirely, so that they remain partly in the urethra, and partly in the bladder. Pointed objects, as safety-pins, hatpins, or hairpins, are much more apt to have their points embedded in the wall of the urethra than they are in the bladder wall. Since these objects are usually introduced point last, this embedding may constitute a serious obstacle to their removal. In other cases, especially if the two limbs of an object like a hairpin or a safety-pin tend to spread apart, one of them may work its way through the wall of the urethra and the surrounding tissues as well, eventually perforating the skin and appearing on the surface of the penis or perineum. An especially interesting group is that in which a bit of solid silver nitrate is lost in the urethra during endoscopy. If not promptly removed or expelled, serious damage, with perforation and necrosis, may occur.

Long and flexible objects, such as filiforms, may become much rolled up or even tie themselves into knots. Calcareous encrustation is common, but not so marked as in the bladder.

Urethral foreign bodies may or may not cause urinary obstruction, depending on the size, shape, and location. Solid rounded objects are, of course, much more likely to occlude the lumen. Certain things, such as seeds or pieces of wood, may swell by absorbing water from the urine and so produce obstruction.

As in the bladder, the commonest complication is infection. The urethritis is often not severe, but if infection is combined with perforation, periurethral abscess, extravasation of urine, and fistula formation may follow. The object may be extruded in this process, or may remain in place. Simple urethritis due to foreign body may be accompanied by epididymitis, especially if the object presses against the verumontanum.

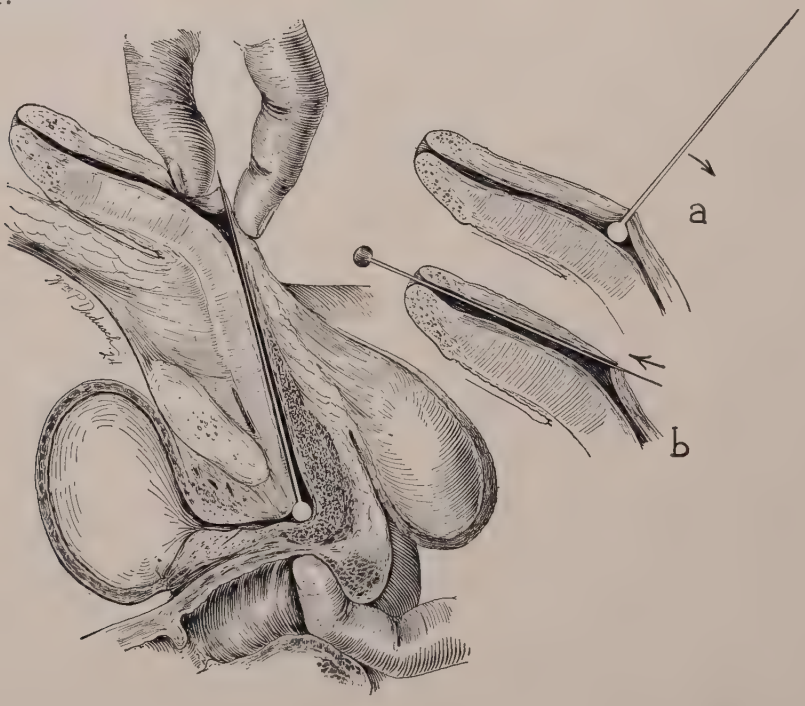
The *symptoms* of foreign body in the urethra are pain, and dysuria, without frequency. There may be frequency, however, in a few cases, (1) in which theobject irritates the posterior urethra or verumontanum, or (2) in which a hollow object, like a piece of catheter, is arrested in the internal or external sphincter. There may be some bleeding (urethrorrhagia, independent of voiding), depending on the nature of the object and on the violence accompanying its introduction or the efforts made to remove it. Penetration of the corpora cavernosa, which is very rare, may cause serious hemorrhage. Difficulty of urination may be present or absent, as stated above. With the onset of infection there is a urethral discharge, and one may sometimes see edema of the penis. Complications, such as periurethral abscess, extravasation, etc., give their characteristic symptoms.

The ease of the *diagnosis* depends largely upon the correctness of the history obtained. Patients often attempt to conceal the fact that they have put something in the urethra, or, if the object is an instrument left in accidentally, may be in ignorance of the occurrence. The two most important means of diagnosis are palpation of the urethra and endoscopy. Since practically every part of the urethra is available for palpation, if one includes rectal examination, except the prostatic portion, it will usually be possible to detect the object unless it is very small. At the same time we learn the location. Additional information is often obtained by having a small bougie à boule in the urethra at the time of palpation. Endoscopy gives a direct view of the object, so that peculiar features, such as irregularities, sharp points, embedding in the urethral wall, etc., can be seen. In the presence of advanced strictures, endoscopy is impossible, and one is confined to the history, palpation, and *x*-ray.

It is best to use the open, straight-end endoscope, which may be pushed right up to the object, and which may also suffice for its removal. The serious obstacle which may be met is persistent hemorrhage from the mucosa.

The *treatment* is (1) by means taken to favor spontaneous expulsion; (2) by pushing the object into the bladder, with subsequent removal by lithotrite, rongeur forceps, or cystotomy; (3) by endo-urethral removal by forceps, with or without the aid of the endoscope, and (4) by urethrotomy.

Prevention is the best cure, and if one makes sure that all his instruments are in perfect condition before use, and exercises care and skill in his maneuvers, he will have fewer foreign bodies of surgical nature to remove from the urethra and bladder.



FIGS. 618, 619.—Showing removal of hatpin from urethra. Pressure is made upon skin over point of the pin in the urethra and forced through by pressure from behind. Point of pin caught with forceps, drawn out through puncture wound, and then carried backward *a*. Pin pushed out head foremost through meatus, *b*.

Spontaneous expulsion can seldom be brought about. However, if the object is of suitable size and shape, one may try injections of oil, which when allowed to flow out following distention of the urethra, may bring the object with it.

Smooth and rounded objects, especially if they are such as can be crushed, may be pushed into the bladder, and removed by any of the means described for vesical foreign bodies. This sometimes occurs unintentionally during exploration of the urethra.

Endo-urethral removal is the ideal, but is often difficult. Objects which can be seized, and which have no sharp points, may be removed from as far back as the bulbous urethra by inserting a small straight forceps in the urethra, with the additional guide of a finger in the perineum or on the lower surface of the penis. With more irregular and pointed objects, it is necessary to see them, and an endo-

scope should be used. Pointed objects present difficulties, which may sometimes be overcome by using the various maneuvers described by Chevalier Jackson for use with the bronchoscope. If it is necessary to get the blades of the forceps between the object and the walls of the urethra, they must be thin and lie exactly parallel to the urethra wall. It is useless to try to seize an object unless one can get well around it. Where sharp points are directed outward, as with safety-pins, hatpins, or hairpins, they must be carefully brought within the end of the urethroscope, pushing the object slightly back if necessary to free the points from engagement in the urethral wall. If there be more than one point, the longer one must be got inside the endoscope first. When all points are protected inside the endoscope, keeping a firm grip with the forceps, one pulls out forceps, endoscope, and pin all together.

A special maneuver very useful in the case of a hatpin is to fix the head of the pin in place with a finger in the rectum, to prevent it slipping into the bladder, to push the point through the tissues and skin of the penis at whatever point it may happen to be, and then to draw the pin out as far as it will come. The pin can then be reversed, the head pushed out of the meatus, and the remainder drawn back through the hole in the skin (Figs. 618, 619). The small penile fistula so created gives no trouble and heals without leaking.

Urethrotomy.—If the foreign body cannot be removed with instruments, and will probably not pass, or if the patient has complete obstruction to urination or great pain, urethrotomy may be necessary to remove the foreign body. When it is lodged in the pendulous urethra near the meatus it may often be removed a meatotomy or urethrotomy carried out by means of a sharp-pointed, through slender bistoury, after which the foreign body may be expelled by pressure behind or grasped with forceps and removed. Where it is impossible to remove it through the meatus efforts should be made to push the foreign body backward into the bulbous urethra, where it can be removed by urethrotomy with less danger of permanent urinary fistula. If this is impossible it may be necessary to cut down upon the object in the pendulous urethra. By making the incision along the side of the penis a centimeter or more distant from the midline of the urethra the skin may be elevated and the urethra opened. After removal of the object the urethra and skin can be closed in layers with less danger of fistula formation.

Perineal urethrotomy may be employed to remove foreign bodies and is the point of election for opening the urethra because, as previously stated, the thickness of the perineal tissues is more propitious for ultimate closing of the fistula.

If the foreign body projects into or lies back within the deep urethra and is of a size too great for removal through the external sphincter without division or dangerous dilatation, the incision to remove the object should be posterior to the external sphincter and triangular ligament, either unilateral or bilateral, as for prostatectomy, the technique of which is similar for that employed in removal of objects in this region. If marked suppuration in the prostate is present, it may be advisable to drain.

CHAPTER XI

ULCERATIVE LESIONS OF THE EXTERNAL GENITALIA

SYPHILIS

Pathology.—*Chancre.*—The primary lesion of syphilis is usually located on the penis. This lesion may take a variety of forms, of which we may mention (1) the hard or Hunterian chancre; (2) the superficial or parchment chancre; (3) the mixed ulcer, in which the syphilitic process develops in a chancroidal or other ulcer, where its own characteristics are often obscured. For a description of the hard chancre we can do no better than quote Hunter's[1] own words: The lesion "begins first with an itching in the part; if it is the glans that is inflamed, generally a small pimple appears full of matter, without much hardness, or seeming inflammation, and with very little tumefaction, the glans not being so readily tumefied from inflammation as many parts are, especially the prepuce; nor are the chancres attended with so much pain and inconvenience as on the prepuce; but if upon the frenum, and more especially the prepuce, an inflammation more considerable than the former soon follows, or at least the effects of the inflammation are more extensive and visible. Those parts, being composed of very loose cellular membranes, afford a ready passage for the extravasated juices. . . . The itching is gradually changed to pain; the surface of the prepuce is, in some cases, excoriated, and afterward ulcerates. In others, a small pimple, or abscess, appears, as on the glans, which forms an ulcer. A thickening of the part comes on which, at first, and while of the true venereal kind, is very circumscribed, not diffusing itself gradually and imperceptibly into the surrounding parts, but terminating rather abruptly. Its base is hard, and the edges a little prominent. When it begins on the frenum, or near it, that part is very commonly wholly destroyed, or a hole is often ulcerated through it. . . ." When complicated by other "common inflammation," the syphilitic process is recognized by the "thickened base, and although in some the common inflammation spreads much further, yet the specific is confined to this base. Chancres on the skin have less inflammation attending them than those on the frenum and prepuce, but more than those on the glans."

This describes well the hard chancre, and the principal details by which we may hope to detect syphilitic involvement in mixed ulcers.

The so-called "parchment chancre" is identical in its pathology except that the process is much more superficial. It is really a wide, thin layer of induration which may not give much impression to the finger pressed directly down on top of it, but when squeezed laterally gives the feeling of stiffness indicated by the above designation. It is slightly elevated, with distinct edges, and shows a slight redness. Ulceration occurs as in most syphilitic lesions, but is seen as a superficial excoriation. Some believe that the character of the lesion is determined by the arrangement of the blood-vessels; that is, where they are numerous and largely at right angles to the skin surface, as in the coronary sulcus and frenum, the deep, hard chancre develops, while where they are less numerous and largely parallel to the

[1] A Treatise on the Venereal Diseases, First American edition, Philadelphia (J. Webster), 1818.

skin, as on the glans and outer surface of the penis, the flat chancre develops. This is, however, hypothetical, and there are many exceptions.

The hard chancre ulcerates regularly, and here the ulceration is deeper, with a punched or gnawed out appearance, and with indurated and slightly overhanging edges. The base is indolent, often with a grayish membrane, but never marked pus formation unless secondary infection (chancroid; "phagedena") occurs. The granular appearance of epitheliomatous ulcers is absent.

Microscopically, in spite of all that has been written on the subject, there is nothing very characteristic. One sees a dense round-cell infiltration, with, in the later stages, many plasma cells. The infiltration shows a certain perivascular arrangement, and the blood-vessels undergo an intimal proliferation which may ultimately lead to occlusion. Just beneath the ulcerated surface there is, of course, some polymorphonuclear infiltration as well, but it is not marked. Treponemata, usually moderate in number, can be found in properly stained sections. The round cell infiltration extends out for some distance under the unbroken skin, and in this area the epithelium may show proliferation, with hypertrophy of the papillæ, and

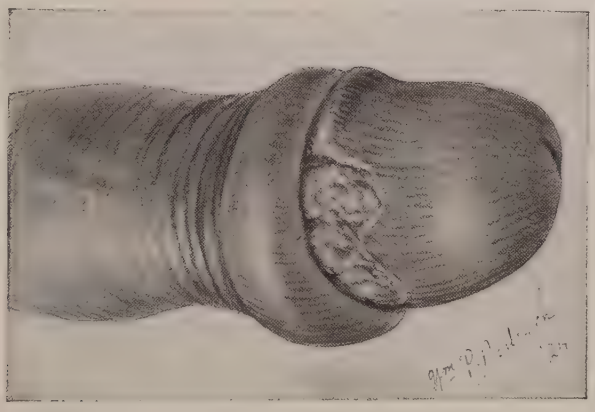


Fig. 620.—Chancre, showing the usual location in the coronary sulcus.

lengthening of the interpapillary processes. Close study shows, however, that these never extend very far and that the basement membrane is intact, so that there should be no confusion with malignancy.

In connection with chancre there is regularly a syphilitic inguinal adenitis. The pathology consists of an intense round-cell infiltration, causing the nodes to be enlarged and firm. There is little periadenitis, so that the nodes remain discrete, and ulceration or abscess formation is exceptional, unless there is severe secondary infection. This is the characteristic "indolent bubo" of chancre.

Chancre may be multiple, though this is the exception. Keyes mentions a case in which there were 21 lesions.

The *location* of chancres is quite variable. The commonest is in or just behind the coronary sulcus, often near or at the frenum, really on the internal surface of the base of the prepuce. This is probably because this region is most likely to be traumatized. Chancre may be at the meatus, in which case it may be circular, involving the entire periphery, or crescentic, involving only a portion. It usually extends down the urethra a variable distance. Other locations are on the glans,

prepuce, or shaft. The base of the penis, scrotum, lower abdomen, or thighs are infrequently the site of chancre, but, as is well known, any part of the body may be involved. Cases have been reported of chancre in the wound of ritual circumcisions, in which the infection proceeded from the operator.

Gumma.—Tertiary syphilitic lesions involve the penis, probably oftener than is usually supposed. In some cases this involvement is precocious, a short time following the secondary eruption. This is spoken of in the older literature as "chancre redux." Such lesions probably account for a number of the cases of supposed reinfections in syphilis. They are more apt to be multiple than the primary lesion. There is no especially preferred location, and there is no associated "indolent bubo," though inflammatory lymphadenitis may follow secondary infection.

The lesion is always deep and indurated, and ulcerates regularly. If untreated, it may be spreading and destructive—it is really a superficial gumma. The pathology is similar to that of the primary lesion. Treponemata are much more difficult to find, but are present.

Fig. 621.—Gumma or tertiary syphilitic lesion involving the glans, sulcus, and shaft of the penis.

Symptoms.—The one important and striking symptomatic feature of syphilitic lesions of the penis is their *painlessness.* This is one reason why the primary lesion so often goes entirely unnoticed in women. As mentioned by Hunter, there may be a slight itching or tingling sensation. This often leads to the scratching off of the crust, which initiates the *ulceration.* The ulceration is resistant to all local treatment, but if uncomplicated, is usually not very extensive. It finally heals spontaneously, but sometimes not until after the secondary eruption has commenced. A contracted *scar* is left, which is permanent, and if it involves the urethra, it may cause stricture there. If the chancre is secondarily infected, the ulceration may be destructive, and cause urethral fistula (usually on the ventral surface of the penis) or loss of a portion of the organ. This secondary infection may be chancroidal, or of the phagedenic type, which is usually supposed to be principally due to a streptococcus infection. There may also be infection of the type in which the organisms typical of Vincent's angina are found. If the syphilitic infection commences in a pre-existent ulcer, there may be no alteration in the symptoms whatever. The first thing, in such a case, to attract the attention of the patient may be the secondary eruption.

Diagnosis.—The diagnosis of syphilis of the external genitalia, especially the primary lesion, is a matter of the utmost importance. The principal features of the typical lesions have been described above, but it will be seen that in many cases a definite diagnosis may be impossible from inspection of the sore. In former days it was customary to wait for the appearance of secondaries, but this is no longer

permissible, as we now know that every day lost in the early stages of syphilis makes the cure more difficult. Every genital ulcer must, therefore, be examined by the *dark-field method*, and if treponemata are not found, the examination must be repeated on several occasions before a negative diagnosis is decided on. During this period no treatment whatever must be given except a dry dressing or salt-solution compress. If antiseptics have been previously applied to the sore, the above treatment should be carried out for twenty-four hours before examining with the dark-field microscope. The reason for this is that any antiseptic powder, solution, or ointment, or even soap and water, destroys the organisms on the surface of the ulcer and makes it impossible to find them. If powder, as for example calomel powder, has been applied, it is necessary that it all be removed before we may expect to discover treponemata.

The specimen may be obtained with a toothpick swab or platinum loop. Trauma must be avoided as far as possible in order to prevent an excess of blood. For this reason fine glass tubes have been recommended, in which the serum rises by capillary attraction. If secretion is scanty, the surface may be wiped gently with gauze. If ulceration has not yet occurred, a few shallow scarifications may be made with a sharp knife. Exudation may be stimulated by the application of a small Bier cup.

In using the dark-field apparatus it is important to be familiar with it and to use it to the best advantage. A condenser with lateral movement is preferable, so that after adjusting the beam of light on its center, one can move it about until a field is obtained in which the background is dead black, and there are no diffraction lines or halation.

The *Treponema pallidum* is 7 to 21 μ in length, and in the neighborhood of 0.5 μ in diameter. It is curled into a very regular spiral, each turn of which is about 1.5 to 2 μ from the next. The regularity and closeness of the spiral distinguish it from other spiral organisms such as occur in the vagina, preputial cavity, and mouth. In fresh specimens the organisms are actively *motile*, and progress through the preparation in the same way that a corkscrew advances through a cork. Small particles are easily pushed out of the way. These organisms, if the morphology is typical, are pathognomonic of the disease, and no further procedures are necessary before beginning treatment.

The *Wassermann reaction* is of no value in early primary syphilis, since it remains negative for two or three weeks after the chancre manifests itself.

Since the incubation period of chancroid is so much shorter than that of syphilis, it is important to watch closely every chancroidal ulcer for any induration or other feature suspicious of syphilis. Treatment is then to be suspended long enough to obtain a satisfactory dark-field examination of the secretion.

The character of the *inguinal adenitis* may be helpful. If epithelioma or tuberculosis come in question, a biopsy is indicated.

Tertiary syphilitic lesions are harder to diagnose. Treponemata are seldom if ever found in the secretion. Inguinal adenitis is usually absent. The history, and the presence of a scar of the primary lesion, are helpful. The Wassermann reaction will usually be positive. Response to antisyphilitic treatment is the final diagnostic point.

Another lesion of the genitalia which has been described is the condyloma or syphiloma. There is, however, some doubt about its relation to syphilis. It con-

sists of a productive granulomatous process which gives rise to large fungating masses, with superficial ulceration.

Microscopically, one sees an intense infiltration of round-cells and plasma cells, and fibrous proliferation. Treponemata are usually not demonstrable. The condition is practically confined to women of uncleanly habits, and may involve the entire vagina and perineum. Similar lesions are occasionally seen about the anus in males. The response to antisyphilitic treatment is slow or absent.

Treatment.—*Prophylaxis.*—The world is indebted, for the success which has been attained in the prevention of syphilis, to Metschnikoff, who made the fundamental researches with the experimental disease in apes, and to Maisonneuve, a courageous student of medicine, who, after offering his arm to be scarified and rubbed with the material from an active chancre, waited stoically for an hour to give the spirochetes a chance to penetrate before applying Metschnikoff's calomel ointment. This success was never more strikingly demonstrated than in the armies during the World War.

Metschnikoff declared, as a result of his work, that if $33\frac{1}{3}$ per cent. calomel ointment is used within an hour after coitus it would prevent syphilis in almost every instance. His work had been accepted by the American Army and Navy, and before our entrance to the World War abundant statistics were at hand to show the great results which had been obtained whenever a thorough "prophylactic treatment" had been carried out, within even three hours after coitus. The venereal rate for the United States Army, which was 155 per 1000 in 1911, when prophylaxis was introduced, fell to 84 per 1000 per year in 1913, and during the World War fell to the very low figure of 16 per 1000. For further details see Chap. XXIII.

The Treatment of Primary Syphilis.—We have no intention to write exhaustively on the treatment of syphilis. The subject is one for a special work. The primary lesion is often seen by the urologist and may demand immediate treatment, especially as it is complicated by chancroid in a large percentage of the cases.

After the usual dark-field examination of secretion from the surface of the sore has been made, if spirochetes have not been found, it may be desirable to treat the lesion with salt solution compresses until further examinations prove that it is not syphilitic.

In cases of marked suppuration, and especially if the lesion is very ulcerative and undermined so as to suggest chancroid strongly, antiseptic treatment may be advisable regardless of the danger of eliminating the spirochetes and preventing early recognition of syphilis. When a diagnosis has been confirmed by finding the spirochetes no time should be lost in beginning arsenical treatment.

There is great diversity of opinion among recognized syphilographers as to every detail of the therapy of syphilis. We, therefore, cannot pretend to lay down any hard-and-fast rules. It is abundantly proved that some form of arsenic, either arsphenamin, neo-arsphenamin, or some of the more recent arsenical compounds should be used. In the American Army we adopted the novarsenobenzol of the French, but there are many who prefer the old salvarsan. Whichever is used, a thorough course of treatment should be given over a period of six weeks, after which a rest is required. Sulpharsphenamin has the advantage of not requiring intravenous injection, and appears to be fully effective.

Authorities are practically agreed that some form of mercury should be used in conjunction with an arsenical, but there is much divergence of opinion as to

what salt of mercury to employ and whether it should be given during the period of arsenical treatment (on the days between) or whether it should be commenced after the cessation of the course.

After seeing the apparent inefficiency of most mercurials and the frequency of manifestations of mercurialism (mouth, intestine, and kidney) we have experimented with various new compounds of mercury which were produced in our researches on germicides in the Brady Institute and have found, as a result of a long series of experiments with different mercurials in the treatment of rabbit syphilis, that one of our new drugs which we have called flumerin[1] is the least toxic and most efficient intravenous mercurial. At least eight times as much mercury can be introduced intravenously with flumerin as with the cyanid of mercury.

The bismuth compounds have shown good therapeutic results. They are more comparable to mercury than to arsenic, and are usually employed as an adjunct to arsenical treatment.

The usual treatment of syphilis with us is, therefore, a combination of neo-arsphenamin with flumerin—sometimes given on alternate days, each twice a week—or the flumerin reserved until the first course of neo-arsphenamin has been completed.

The treatment must, of course, be controlled by careful urinalysis, and unduly large dosage avoided by regular inspection of the oral mucous membranes. Additional courses of treatment—usually three in number—are given during the first twelve months, after which repeated Wassermann tests will determine whether additional treatment is necessary. But, as remarked before, we have no intention of discussing completely the detailed treatment of syphilis.

In the tertiary lesions of the genitalia, testicle, prostate, kidney, etc., arsenicals and mercurials may be tried, and if they do not succeed iodid of potassium alone or combined with mercury may be used—often with good results.

In syphilis of the testicle care must be taken not to waste too much time on a "therapeutic test" of this sort—remembering that a gummatous testicle or epididymis is usually so irreparably injured that often the best treatment is castration, and that it is difficult to rule out malignant neoplasm without exploration.

In cerebrospinal syphilis with vesical disturbances (residual urine, incontinence, etc.) energetic antisyphilitic treatment is often helpful and occasionally remarkably curative. We have used arsphenamin and flumerin intravenously, and also salvarsanized or mercurialized serum intraspinally. The intravenous methods alone seem to be the most effective, but here again no fixed rules can be given.

CHANCROID

This designation has come down from the days when an exact diagnosis of syphilis could not be made, and physicians spoke of the "hard chancre" and the "soft chancre." Latinized, we have "ulcus molle." A name more distinctive than chancroid would be desirable, but is scarcely to be hoped for.

Pathology.—The disease is due to a specific bacillus discovered by Ducrey.[2] (Hemophilus Ducreyii, S. A. B.). This organism is a short, plump, almost coccoid bacillus, 1.5 to 2 μ in length, Gram-negative, and growing in very long, tortuous chains. Culturally, its food requirements are complicated, and it will not grow

[1] Hill and Young: Journal of the American Medical Association, 1923, lxxx, 1365–1369.

[2] Monatsschrift für Praktische Dermatologie, 1889, ix, 387.

on any of the ordinary laboratory media except those containing blood. The best growths reported are on coagulated rabbit blood which has been heated at 55° C. for thirty minutes. On blood-agar the colonies are small, opaque, and can easily be pushed about entire on the surface of the medium. Owing to the growth in interlacing chains, the colonies are tenacious, and do not easily form an emulsion. A small zone of hemolysis appears on the third day. The organism is rather resistant, and after forty-eight hours in the incubator may be kept alive in the ice-chest up to thirty days.[1] In unfavorable media involution forms develop. These are much larger and longer, often with bipolar staining and fusiform shape. Serological tests have, up to the present, failed to show any distinct strains.

The most frequent site of chancroid in the male is the coronary sulcus, but it may begin at any point on the penis. Spontaneous extragenital infection is very rare. Some degree of trauma to the skin is apparently necessary for a "take." In women, the ulcer is usually on the vulva, seldom any distance within the vagina. The lesion is often single, but is much more apt to be multiple than chancre. Multiple ulcers may become confluent.

Fig. 622.—Chancroid of the glans penis. The lesion is superficial. In this case there was also suppurative inguinal lymphadenitis.

Pathologically,[2] the lesion caused is essentially destructive and not markedly proliferative. According to the aphorism of Keyes, "chancre is a lump, chancroid is a hole." There is at first an area of reddening and congestion, then a pustule, which opens and leaves a rather punched out ulcer. The base of the ulcer is irregular, necrotic looking, and covered usually by a yellowish purulent membrane. The edges are often somewhat undermined. The surrounding area is reddened, but not indurated, nor is induration to be felt beneath the base. Microscopically, one sees a moderate infiltration with both round and plasma cells. Polymorphonuclear cells are also present, most numerous near the ulcerated surface. There is no fibrosis, and the blood-vessels are little involved, showing no intimal proliferation, although the infiltration has a perivascular arrangement. The specific organisms are difficult to demonstrate, but can sometimes be seen lying in long rows in the tissues. They are most numerous in the necrotic area in the base of the ulcer, but extend out at least as far as does the infiltration. The epithelial edges of the ulcer show nothing of consequence.

Involvement of the regional lymph-nodes (inguinal) is very common, indeed almost the rule. Often rather indolent at first, periadenitis with matting together of the nodes may occur, followed by suppuration and rupture. Rupture seems sometimes to increase the virulence of the organisms, so that a large chancroidal ulcer, retaining the general characteristics of the primary growth, may be formed. This metastasis to the regional nodes sometimes occurs late, when the primary lesion is almost healed.

[1] Teague and Deibert: Journal of Medical Research, 1922, xliii, 61–75.

[2] Compare Unna: Monatsheft für praktische Dermatologie, 1892, xv, 485; 1895, xxi, 61.

It is possible to perform auto-inoculation anywhere on the body with pus from these ulcers. Spontaneous auto-inoculation may occur on surfaces in contact with ulcers, as the thigh or scrotum. This apparently indicates that little or no generalized immunity develops, in spite of the fact that chancroid is a self-limiting disease

Chancroidal ulcers are prone to secondary infection, which is facilitated by phimosis. This may be with syphilis (chancre or gumma), with the organisms of Vincent's angina, or with any variety of pyogenic organisms. Diphtheroid bacilli are usually present on the surface, but are probably not pathogenic. The results of this secondary infection depend on the virulence of the organism concerned. Thus with gumma, Vincent's angina, streptococcus, etc., extensive destruction may occur, with fistulæ, gangrene, loss of substance, etc.; the sort of thing included under the general designation of "phagedena."

Symptoms.—Symptomatically, chancroid is marked by a short incubation period (twenty-four to seventy-two hours) and by the presence of pain. The pain may be severe, and the tenderness exquisite. Discharge from the ulcer may be profuse and purulent. With inguinal involvement there may be fever and prostration, if severe, and these lesions are also painful. The course of the disease is from six to eight weeks, if untreated, and in the absence of complications spontaneous healing is to be expected. The lesions heal with comparatively little scarring, due to the absence of fibrotic change. Inguinal adenitis may prolong the course markedly. Chancroid is essentially a disease of filth. Moore[1] has shown that soap and water prevent chancroid absolutely, even after artificial inoculation. It is, therefore, very uncommon in those of cleanly habits.

Diagnosis.—The diagnosis of chancroid is surrounded by the uncertainty which marks all genital ulcers. As in syphilis and granuloma inguinale a large proportion of the cases is atypical, due usually to complications. The features to be sought for on examination are described in the paragraphs on pathology. The most important point in diagnosis is to rule out *syphilis*, and this is done by means of the dark-field examination. Chancre may, however, develop at any time during the course of chancroid, as, for example, if both infections are contracted at the same coitus, when chancroid will appear in about two days, the chancre about three weeks later. A single examination, therefore, will not rule out syphilis, and the examination must be repeated upon the appearance of any suspicious induration in the sore at any subsequent time.

Granuloma inguinale is characterized by its more proliferative character and by its response to tartar emetic injections. In addition, the organisms are not difficult to demonstrate in smears.

The bacillus of Ducrey is not readily demonstrated in smears. The chains break up in pus, leaving the short, Gram-negative bacilli which are not at all characteristic among the numerous surface invaders. Teague and Deibert,[2] however,

[1] Journal of Urology, 1920, iv, 169–175.

[2] Journal of Urology, 1920, iv, 543. The method consists in the preparation of small tubes containing each about 1 c.c. of sterile clotted rabbit blood, which has been heated at 55° C. for five to fifteen minutes. A bit of pus from the base of the ulcer or from the undermined portion is picked up with a piece of stiff iron wire (kept ready sterilized) and placed in the serum surrounding the clot. Previous irrigation of the ulcer is not necessary. Examination is made after incubating for twenty-four and forty-eight hours, the morphology and staining reaction giving the diagnosis, even in the presence of other organisms. The authors claim that their results were positive in about 90 per cent. of the cases which were not obviously non-chancroidal.

have stated that cultural diagnosis is simple and as reliable as that of diphtheria, since in the culture medium the organism retains its characteristic long-chain morphology. This feature, with the Gram-negative character and inability to grow on blood-free media, are considered sufficient by Stümpke[1] to identify the organism. It appears that the method of Teague and Deibert should come into wider use.

Treatment.—Having decided that a genital ulcer is chancroidal, and that syphilis definitely is not present, treatment may be commenced. The greatest variety of treatments has been recommended. They may be classified as antiseptics, either fluid (wet dressings), dry (powders), or as ointments; and physical means, as cauterization, fulguration, hot air, sunlight, etc. Operative measures are seldom called for, except in the incision of a chancroidal bubo, or in the splitting of a persistently unretractable prepuce. After very severe cases, plastic operations may be necessary to close fistulæ or repair other defects.

Efforts have been made to induce immunity, both active and passive, in the treatment of chancroid. Reenstierna[2] produced an antiserum by injecting cultures of the bacillus of Ducrey into a sheep. He claimed to have reduced with this serum the average healing time, in a series of 100 cases of chancroidal bubo, from four weeks to one week. There has been little confirmation of this. Stümpke[3] used a Ducrey bacillus vaccine, containing about 10,000,000 killed organisms per cubic centimeter, intramuscularly and intravenously, at intervals of three or four days. He claims excellent results with the primary lesions, four doses being the maximum necessary to effect a cure, while healing was observed to begin after the first injection. The results with buboes were not so striking. Neither of these methods of treatment has yet emerged from the experimental stage.

Of the antiseptics recommended, bichlorid of mercury, permanganate of potassium, mercurochrome (compresses or ointment), iodoform, and argyrol crystals may be mentioned. None of these is especially effective, and the argyrol crystals have the additional disadvantage of being very painful. Hot air has been recommended, as well as constant exposure to open air and unobstructed sunlight. Thorough fulguration of the lesions has been a fairly successful treatment in our hands. A solution of copper sulphate may be applied to the ulcer beforehand, but this is not necessary. Cauterization, with the actual cautery, phenol, or fuming nitric acid has also been recommended. If cauterization is incomplete, however, the only result is an increase in size of the chancroidal ulcer.

In our clinic, all other treatments have been replaced by that recommended by Rosenwald.[4] The antiseptic used is a modified black wash, as follows:

Calomel	℥j
Zinc sulphate	℥ij
Camphorated fluidextract of opium	℥ij
Lime-water	℥viij

The calomel and lime-water are mixed and allowed to stand two days, with frequent shaking. The other ingredients are then added.

[1] Archiv für Dermatologie und Syphilis, 1922, cxxxviii, 304–306.
[2] Münchener Medizinische Wochenscrift, 1920, lxvii, 895, 896.
[3] Archiv für Dermatologie und Syphilis, 1922, cxxxviii, 304–306.
[4] Urologic and Cutaneous Review, 1923, xxvii, 553.

The solution is turbid, and must be shaken before use. A pledget of cotton saturated with it is placed on the lesion after thorough cleansing and allowed to remain in place one to three hours. The remainder of the time the ulcer is simply kept clean, or an analgesic ointment may be applied. The treatment is repeated only once or twice a day. The results of this method of treatment are most gratifying, the time of healing being reduced about 75 per cent. The old, chronic, rebellious chancroids which have always been such an unpleasant feature of genito-urinary clinics are now practically never seen. The only objection to the treatment is that it is sometimes painful. This may be alleviated by applying procain before the treatment, and by giving aspirin or other analgesic afterward.

Slitting of the prepuce is seldom necessary. A piece of cotton soaked in the fluid may be placed in the preputial cavity if there are ulcers there, and usually brings about healing. Buboes are to be incised only when definite fluctuation is present. The resulting ulcers are treated in the same manner as the penile chancroids.

In the prevention of chancroids soap is the most efficient prophylactic. Moore[1] found that washing with soap and water prevented inoculation in every instance, while the application of calomel ointment did not.

GRANULOMA INGUINALE

Pathology.—This condition is a genital ulceration sufficiently characteristic to have been first described as a clinical entity aside from any bacteriologic or therapeutic desiderata.[2] The first case is attributed to McLeod, in 1882. Various organisms were subsequently found in the ulcers, but in 1905 Donovan[3] described the organism which is now thought to be the causative agent. He considered it to be a gregarine parasite similar to the Leishman-Donovan bodies of kala-azar. All recent writers are unanimous in believing this organism to be the cause of the disease, but there is great disagreement as to its nature. For example, Seibert[4] and Martini[5] felt that it was an encapsulated diplococcus, and Flu[6] cultured it as an encapsulated bacillus. Aragâo and Vianna[7] held to the encapsulated bacillus, but felt that the organism represented a new genus of schizomycetes, which they called Calymmatobacterium. Walker,[8] Randall, Small and Belk,[9] and Lynch[10] saw and cultured the organism as a Gram-negative encapsulated bacillus, similar to the Friedländer or mucosus capsulatus group. Gage[11] reverts to the opinion that the organism in question is protozoan.

In consequence of this disagreement, we cannot at present give the organism

[1] Journal of Urology, 1920, iv, 169–176.

[2] Walker: Journal of Medical Research, 1918, xxxvii, 427–440.

[3] Indian Medical Gazette, 1905, xxxix, 414.

[4] Archiv für Schiffs und Tropenhygiene, 1907, ii, 379–389.

[5] Ibid., 1913, xvii, 160–166.

[6] Ibid., 1911, xv (beiheft 9), 477–492.

[7] Memorias do Instituto Oswaldo Cruz, 1913, v, 221–238, and Aragâo, New Orleans Medical and Surgical Journal, 1917, lxx, 369–374.

[8] Journal of Medical Research, 1918, xxxvii, 427–440.

[9] Journal of Urology, 1921, v, 539–548, and Surgery, Gynecology, and Obstetrics, 1922, xxxiv, 717–739.

[10] Journal of the American Medical Association, 1921, lxxvii, 925.

[11] Archives of Dermatology and Syphilology, 1923, vii, 303–325.

a definite name. In the lesions, it is found in all parts, especially in the deeper areas, where all other organisms are absent. It is typically intracellular, and occurs in the cytoplasm of the large endothelial leukocytes. The smallest and apparently earliest forms are very narrow and short rods, staining blue with any of the Romanowsky stains, and lying in a vacuole in the endothelial leukocyte. Later they grow all through the cytoplasm and still later are seen to be embedded in a mass of light pink staining material. This picture is spoken of as a zoögleal mass, and the embedding substance is that which later goes to make up the capsule or "cytoplasm" of the organism. It eventually breaks up into little globules, each surrounding one of the dark blue rods. The leukocyte is often distended by the mass of organisms, and at length bursts or disintegrates, setting the organisms free in the surrounding fluid. Since comparatively few are found in the free state, we may assume that they quickly parasitize other leukocytes. The organisms when free may be very short, almost coccoid, or longer and sometimes slightly curved. In others, the blue staining rod is divided into two bodies, lying at opposite poles of the capsular mass, which may show an equatorial constriction. This is supposed to represent a stage of division. The entire organism is Gram-negative and stains poorly with the ordinary bacterial stains.

Culturally, the encapsulated diplobacillus form only is retained, except on Sabouraud's medium, where forms resembling more closely those encountered in the lesions develop. The organism can apparently grow in the test-tube without passing through the zoögleal stage. On the other hand, Gage feels that an encapsulated Gram-negative bacillus cultured by him bore only an accidental resemblance to the parasites seen in the lesion. Inoculation experiments have produced in animals abscesses with some resemblance to granuloma inguinale, but never with its characteristic chronicity.

Granuloma inguinale is largely a tropical disease, but recent studies show that it is by no means a great rarity in temperate climates. The first cases came from India, and other localities mentioned include Guiana, Brazil, the West Indies, West Africa, Tripoli, South China, North Australia, New Guinea, and the South Sea Islands. Gage has collected 45 cases reported in the continental United States, largely in the Southern states, but coming also from New York, Philadelphia, and St. Louis. We have seen a number of cases in the Urological Dispensary of the Johns Hopkins Hospital. The majority of the cases has been in colored persons.

Pathologically, the lesion caused is a proliferating, sclerosing, but not necrotizing, granuloma. It usually follows venereal exposure. In males, it usually begins on the penis and especially in the coronary sulcus, but may commence on the shaft, at the base, on the scrotum, or even in the groins. In females, the primary location is often in the perineum or vulva. At first there is a firm papule, which grows larger, and finally excoriates on the surface. This ulceration continues to spread and flourishes best where the surface is damp, hence the preference for the vulvar, preputial, inguinal, and anal regions. Lumps or papules, similar to the primary lesion, may appear beyond the advancing borders of the ulcers. Certain areas may become quiescent and epithelialize from bits of epithelium or interpapillary processes left behind at the time of ulceration. In such areas the surface is rough and irregular, due to the alternation of sclerosis and infiltrated granulation tissue, and the epithelium is thin, smooth, glistening, and often devoid of pigment.

Where the lesion is active and ulceration present, the edge and base are markedly proliferated, masses of firm, infiltrated granulation tissue projecting above the surface and rolling out over the edges. On the glans and prepuce, this marked proliferation may simulate epithelioma. The surface is irregular, and shows only moderate tendency to become purulent; in fact, on exposed areas, like the abdomen or thigh, the surface may be almost dry.

Microscopically, there is a dense infiltration with round cells and large endothelial leukocytes. Plasma cells are not abundant. There is a marked perivascular arrangement of the infiltration, but vascular occlusion is not the rule. In the masses of granulations, the picture is similar, with the addition of edema, vascular dilation, and congestion, while normal elements, as hair follicles, sweat glands, etc., are, of course, absent. Fibrosis is everywhere marked, so that in the older parts of the lesion, the field may be almost filled with thick, interlacing bands of dense or even hyaline connective tissue. Especially in the interstices of these bands, there may be arrangements suggesting tubercules, but with endothelial leukocytes in the periphery and round-cells in the center, and there are never any giant-cells or caseation. In sections stained properly, the parasites can be seen in the endothelial leukocytes throughout the lesion, as described above. The epithelium at the edge of the eroded area is markedly changed, showing great hyperplasia, apparently the result of unsuccessful efforts to grow over the ulcer. The interpapillary processes may be irregular, greatly elongated and extend deep into the infiltrated subcutis, and abortive pearls may even be seen. This picture may suggest an early epitheliomatous change, and indeed it is probable that such a thing does occur in cases of very long standing.

The spread of the disease is on the surface, and deep destruction usually does not occur unless there are complications. The spread is directly by a creeping process, by ulceration of the discrete papules described above as occurring just beyond the advancing edge, and by contact infection with surfaces in apposition. The lesion may extend far, generally in the direction of the abdomen, thighs, and anus. Large "butterfly patches" may be seen on the abdomen. The vagina may be invaded in females, but the cervix escapes. Rectovaginal fistulæ may be caused. Involvement of the lymph-nodes is rare. It should be remembered that while the groin is a common location, the disease does not begin there as an adenitis.

Complication can occur with syphilis, primary or tertiary, chancroid, or epithelioma. The destruction may then be very great, especially with tertiary syphilis. Edema and elephantiasis of the penis, scrotum, or vulva may occur.

Symptoms.—The incubation period is uncertain. Gage reports a case in which it was fixed at one month. At first, in addition to the appearance of the papule. there may be only a slight itching. Later the ulcerations may be very painful and tender. The general health is not affected except in very extensive cases. In cases not arrested by treatment the lesions may persist and spread for an indefinite period; durations up to fifteen years are reported.

Diagnosis.—The diagnosis of granuloma inguinale is often possible by inspection, as the typical lesions described above are quite distinctive. In complicated cases, cases with severe secondary infection, or those confined to the penis (coronary sulcus), the diagnosis may be difficult. Chancroid seldom comes into question. With syphilis, the *dark-field examination*, for primary lesions, and the Wasser-

mann test, for tertiary lesions, give important evidence. The Wassermann should be taken in all cases. Tuberculosis and epithelioma, if suspected, demand a biopsy.

The *history* is valuable in all but recent cases. The slow development and progressive course are very suggestive. The microscopic examination is very important. Preferably a bit of tissue should be obtained from the base of the ulcer, from which smears or sections may be prepared. The staining must be with some modification of the Romanowsky stain. The characteristic organisms are seen in the endothelial leukocytes.

The response to treatment with *antimony* gives the confirmation of the diagnosis.

Treatment.—Aragâo and Vianna first suggested the use of tartar emetic in the treatment of granuloma inguinale. Their success has been confirmed by workers all over the world, and it is now the accepted procedure. It has wrought a great change, since previously all drug treatments, cauterizations, etc., were very unsatisfactory, while surgical removal, even when possible, was often followed by recurrence. Tartar emetic is given according to exactly the same plan as that described for bilharziosis (see Vol. I, page 357). Randall has recently experimented with sodium antimony thioglycollate and antimony thioglycollate triamid with results indicating that the former is as effective as tartar emetic and probably less toxic. Colloidal antimony has also been used.

The results of antimony treatment are excellent. Most cases will yield to it, even the very severe ones of long standing, if one persists long enough. The healing may take four to six weeks, or longer. If the lesions have been extensive, there will be much scarring, but this cannot be prevented. Gage calls attention to the possibility of recurrence, and recommends injections of tartar emetic at intervals of one to two weeks for at least six months after healing. With the same possibility in view, surgical repair of fistulæ, strictures, and elephantiasis should be postponed for six to twelve months after healing of the ulcers.

In some cases surgical removal has been employed in conjunction with the antimony treatment, to hasten the healing, but it is doubtful if this is advisable.

HERPES OF THE EXTERNAL GENITALIA

Pathology.—Herpetic lesions develop occasionally on the penis, especially in the preputial cavity, and on the vulva. When seen in the early stage, they are characterized by their vesicular nature, without inflammatory base. The contents of the vesicles is a clear or only slightly turbid fluid. Microscopically a slight lymphocytic infiltration is seen, without distinguishing characteristics. In later stages the vesicle breaks or is scratched open. Infection ensues, and there is an excoriation or superficial ulceration. Induration is absent.

Symptoms.—The only symptoms are itching or slight pain, with occasionally edema of the parts involved. Inguinal adenitis may follow secondary infection. Healing is usually rapid, with the simplest treatment, and no scar is left unless the secondary infection has been severe.

Diagnosis is best made altogether by exclusion. We are never justified in making light of any ulcer, however slight, on the external genitalia.

Treatment.—The treatment is expectant; a dusting powder may be used, and the lesions should be kept clean and as dry as possible.

BALANOPOSTHITIS

Pathology.—Inflammation of the membrane lining the preputial cavity occurs as a complication of gonorrhea, and as a condition *sui generis*, in which case filth is usually an important accessory cause. Balanoposthitis is particularly apt to occur in those with unretractable phimosis, unless great efforts are made to keep the preputial cavity scrupulously clean.

Ordinarily the infection is superficial and not destructive, but erosions may occur. Inflammatory edema may be present, sometimes with paraphimosis. The microscope shows nothing specific. In diagnosis, it may, in cases where the meatus cannot be exposed, be impossible to determine whether or not acute urethritis is present. A day or two of mild irrigations usually reduces the inflammation sufficiently to allow retraction of the prepuce or dorsal incision. Treatment is by cleanliness and simple irrigations. It may be necessary to remove inspissated smegma, and circumcision should be recommended after the inflammation has subsided.

A special kind of balanoposthitis was first described by Bataille and Berdal,[1] who separated it from the ordinary or banal balanoposthitis on the grounds of its virulence, contagiousness, and specificity. They described it as always following venereal exposure, and consisting of a superficial necrosis which caused opaque white plaques on the preputial surface or glans, different from those due to the epithelial hyperplasia of leukoplakia. Later the necrotic plaques separated, without vesicle formation, leaving ulcers with red base and surrounded by a white rim, consisting of the peripheral portions of the necrotic placque, which had not separated. The ulcers were deeper, and had more definite edges than the erosions of ordinary balanitis. The disease was inoculable from person to person. Constantly associated with it were spirochetal organisms, with wide and irregular spirals. Scherber and Müller confirmed this work, and identified the organism with that described by Vincent in the gangrenous conditions of the mouth and throat which bear his name.[2] The vibrios or fusiform bacilli were most numerous in the deeper parts of the lesion, the spiral forms in the necrotic membrane. The causal relationship of these organisms is not absolutely proved, as is true also in the mouth lesions. It should be remembered that we find them in superficial, benign, quickly healing erosions, also in deep, intractable gangrenes. More bacteriologic work is necessary before we can be sure they are the cause of both.

Later investigations seem to show that there are all gradations from this comparatively benign ulceration to a condition in which the necrotic process advances much faster and further, so that rapid and extensive destruction may occur. The first type is called erosive balanitis, the second gangrenous balanitis.

[1] Comptes Rendus de la Société de Biologie, 1889, xli, 689–691, and Médecine Moderne, 1891, ii, 340.

[2] The spiral organism is large, 6 to 30 μ in length, and slender. The spirals are wide, and somewhat irregular. The extremities of the organism taper off, and there may be a long fine cilium at either end. The motion is active and, in addition to rotation, there is a whip-like movement, similar to that used by a snake. The bacillus or vibrio occurs singly or in pairs joined at the ends. It is about 2 by 0.8 μ in size, fusiform in shape, and slightly curved. The spiral form is Gram-negative and the vibrio weakly Gram-positive. The Giemsa stain or dark-field microscope may be used. Both forms may be cultured on serum agar, but bacteriologic studies have not yet settled whether they represent different organisms growing in symbiosis, or different developmental stages of the same organism.

Corbus and Harris[1] claim for this condition the status of a fourth venereal disease.

Pathologically, there is a certain resemblance to noma and Vincent's angina. The milder lesions are described above. In more severe cases the necrosis is deeper, and the necrotic masses may separate slowly, so that they become black or green, and the fetid odor of gangrene develops. Microscopically, there is very little reaction in the mild cases. In more severe cases there is an infiltration, beyond the areas of necrosis, with round and polymorphonuclear cells, and edema and vascular congestion are very marked.

In the deep cases gangrene may involve any part, or all of the penis. The milder cases are confined to the preputial cavity, where anaërobic conditions are present. Inguinal adenitis occurs frequently, and is usually indolent, without abscess formation. Syphilis may occur as a complication.

Symptoms.—Symptomatically, the disease is a rapid one. The incubation period is uncertain, but probably not over two to four days. The ulcers are usually tender, but not painful. If at all extensive, edema and redness occur, and a long prepuce may be converted into an unretractable phimosis, favoring the progress of the ulceration. There is usually a fairly profuse, rather thin discharge from the preputial cavity, often having a characteristic fetid odor. In severe cases there is marked constitutional reaction, with fever and prostration.

The course of the disease is usually run in a few days or a week. The gangrene is rapid, but once the prepuce is destroyed, not progressive, and it does not extend beyond the root of the penis in the severest cases.

Diagnosis depends on the history and the discovery at examination of the lesions described above. It is often found that there has been contact with the buccal secretions, as in fellatio or in the use of saliva as a lubricant. The characteristic fetid odor is of importance, and the organisms described above may be demonstrated in smears.

When the prepuce is not retractable, study of the secretion is important, since neglect for twenty-four hours may allow gangrene to occur to a serious extent. When this happens the gangrenous areas may show through the edematous prepuce as blue spots, which eventually extend and involve the outer surface, so that a hole may be eaten through, or the entire prepuce sloughed off.

If the history, odor, and microscopic examination lead to the suspicion of this disease, dorsal incision should be made at once, if necessary to expose the lesion.

Complications are detected by the means already described.

Treatment.—The treatment depends largely upon the fact that anaërobic conditions favor the progress of the disease. The preputial cavity is then to be exposed to the air, by dorsal slit if necessary, and kept so exposed. Cleanliness is maintained by irrigations, preferably of hydrogen peroxid. This treatment is usually followed by rapid healing. If gangrene has set in, nothing can be done except to remove necrotic masses and do away with all crevices, cavities, or other places where anaërobic conditions might persist.

GENERAL CONSIDERATIONS, GENITAL ULCERS

All treatises on Urology speak of "phagedena," but in none of them is it defined. We conceive it to be a word used to describe the condition when an ulcer of some

[1] Journal of the American Medical Association, 1909, lii, 1474–1479.

sort becomes more invasive and destructive than it would otherwise be, due to a secondary infection. The nature of the secondary infection may vary. Thus a chancroid, complicated by tertiary syphilis, may become "phagedenic," or, on the other hand, a chancre in the preputial cavity, complicated by gangrenous balanitis, would also become "phagedenic." It is evident that the term has no exact scientific meaning, that it is associated with no specific kind of infection, and that it has been used very loosely. It would be better, therefore, to exclude it from urologic literature in the future. There is reason to believe that any genital ulcer may be complicated by a non-specific pyogenic infection, in the nature of cellulitis or even erysipelas. When such a thing occurs, it is better to speak of it in exact terms.

We may emphasize again the importance of neglecting no genital ulcer. Everyone realizes the necessity for early treatment in syphilis, and the primary lesion of this disease may take on the most varied and deceptive forms. Granuloma inguinale will not improve unless diagnosed as such and treated specifically. Gangrenous balanitis may cause the most distressing mutilations unless arrested early. Every genital ulcer should be carefully examined with the dark-field microscope.

Beyond the definite clinical and pathologic entities described above there is, unfortunately, a small number of genital ulcerations which are most intractable to all forms of treatment, and where a definite diagnosis is impossible. Some of these may be obscure forms of syphilis, with negative Wassermann, others may be tuberculous ulcers in which typical lesions are never obtained at biopsy, in others we cannot even guess at the etiology. One can only advise the greatest patience and persistence. In some such cases we have ultimately obtained healing through rest in bed and constant irrigation with hot, mild antiseptic solutions such as meroxyl, 1 : 2000 or 1 : 4000.

The following two histories illustrate such cases:

Case: Intractable ulcer of penis. Antiseptic treatment. Cure.

B. U. I. 9629, age twenty-two, denies gonorrhea. Had sore on penis two years ago with inguinal adenitis which healed in a short time. History otherwise negative until present illness. Eight months before admission small sore was noted behind the head of the penis six or eight days after exposure. At first it was about 7 or 8 mm. in diameter. During the eight months the sore was treated by three different physicians who used cauterization with nitric acid, carbolic acid, bichlorid of mercury, argyrol, silver nitrate, salvarsan powder, and the actual cautery. The Wassermann was negative three times, but in spite of this six doses of salvarsan intravenously and a course of iodids were given. There was never any tendency to heal, and as a result of the ulceration and of the treatment, about two-thirds of the glans on the ventral surface was destroyed, including the glandular urethra. The urethra opened by a pathologic meatus about 2 cm. behind the coronary sulcus. What remained of the glans was attached dorsally to the shaft of the penis by a very small pedicle. It was, however, sufficiently supplied with blood. The lower surface of the glans and of the shaft for about 2 cm. was covered by the ulceration which was yellowish, unhealthy-looking and undermined at the edges. There was a black crust following the recent application of salvarsan powder. The ulcer was exceedingly painful and tender. Treatment was by rest in bed with continuous hot, wet compresses of boric acid solution. Ten days after admission the crust had disappeared, but the ulcer still looked unhealthy. Intravenous treatment with tartar emetic was begun. There was no change in the appearance of the ulcer, but the pain ceased immediately when the injections were begun. Ten days later meroxyl solutions, 1 : 2000, were substituted for the boric acid. A slow but steady improvement began, so that the ulcer had almost entirely healed two weeks later. Plastic operation was then necessary to tack the freely movable remnant of glans down to the shaft of the penis and restore the urethral meatus. The operative wound healed well, and the patient was discharged. The nature of this ulcer remained uncertain, the only suggestive thing being the cessation of pain

after tartar emetic. The appearance of the ulcer was not, however, that of granuloma inguinale, and no healing was noted until after meroxyl was begun. This case illustrates the value of continuous wet germicidal dressings in these resistant ulcers.

Case: Very painful intractable ulcer of penis. Various treatments tried unsuccessfully. Mercurochrome intravenously. Rapid cure.

B. U. I. 12,056, age twenty-eight, recurrent attacks of gonorrhea for ten years. No sore until present illness. Past history otherwise negative. Sore appeared on glans about six months before admission. This was treated on various occasions with the *x*-ray and was cauterized with nitric acid. Patient also received eight doses of tartar emetic intravenously and four injections of salvarsan. The sore showed no improvement, but became larger. Shortly before admission severe arthritic pain in both hips began. On examination the prepuce was edematous and retracted with difficulty. There was a large ulcer covering the entire dorsal surface of the glans covered with a yellowish slough and showing some undermining of the edges. There were two smaller ulcers on the ventral surface, one near the coronary sulcus, and one near the frenum. There was a purulent urethral discharge in which no gonococci could be found. The lesion was exquisitely painful and tender. Patient was admitted to the hospital and received local treatment with zinc borosalicylate for one week. Then mercurochrome locally for one week. No improvement. On the thirteenth day the lesion was cauterized. Local treatment with mercurochrome was continued and five further doses of neosalvarsan administered. No improvement. On the twenty-seventh day the lesion was cauterized again, and the prepuce removed with the cautery. A section from the edge of the ulcer showed chronic inflammatory tissue with no malignant change or tuberculosis. Local treatment with mercurochrome was continued. Cultures from lesion showed Pseudomonas pyocyanea and staphylococcus. Following the circumcision the entire wound became necrotic and the condition was much worse. On the thirty-ninth day an intravenous injection (5 mg. per kilo) of gentian-violet was given, with no improvement. At this time the patient's condition was markedly worse than on admission and he was in an extremely nervous state, owing to the constant severe pain which made it almost impossible to carry out any local treatment. All applications were discontinued and the lesion was soaked frequently in warm salt solution. On the forty-fourth day an injection of 5 mg. per kilo of mercurochrome was given intravenously. Very shortly after this injection the pain disappeared for the first time since the patient had entered the hospital. There was a marked reaction with temperature of 104° F. On the forty-sixth day another injection of 5 mg. per kilo of mercurochrome was given and on the fifty-eighth day a third injection of 4 mg. per kilo. Patient had some stomatitis and his urine showed a few casts and red blood-cells and trace of albumin, but from the time of the first injection of mercurochrome the lesion healed progressively and rapidly and the pain did not return. On the sixty-sixth day he was discharged from the hospital with the lesion entirely healed except for a small area 5 x 3 mm. His general condition showed the most marked improvement. The pathologic report from the second operation was the same as that from the first. The exact nature of the lesion remained undetermined. The noteworthy feature is that it remained entirely resistant to all forms of treatment except intravenous mercurochrome which brought about a prompt cure.

CHAPTER XII

DIAGNOSTIC SIGNIFICANCE OF SPECIAL SYMPTOMS

PAIN

Pain is a symptom of great importance because it, more than anything else, impels patients to seek assistance from the physician. Other symptoms may be ignored or neglected, but not so pain. Since a number of urologic conditions are not characterized by pain, especially in the early stages, we have here a reason why many cases escape diagnosis during the period when they are most amenable to treatment.

The pain characteristic of urologic diseases can be divided broadly into renal and ureteral pain, vesical pain, urethral pain, prostatic and perineal pain, and scrotal pain. A knowledge of the conditions ordinarily not accompanied by pain is equally important to the urologist.

Renal (and ureteral) *pain* may occur as *constant* pain or in paroxysms of *renal* or *ureteral colic*. Like all visceral pains, they are not felt as occurring at their points of origin, but are referred, usually to the surface of the body, and according to the peripheral distributions of the nerves, the visceral branches of which supply the kidney and ureter.

The *constant* renal pain is usually described as an aching pain, and is less apt to be referred to distant areas than the colic. It is usually appreciated in the loin of the affected side, and, therefore, directly over the kidney region. It may, however, be felt more anteriorly, simulating pain from intra-abdominal lesions or lesions in the region of the diaphragm, or it may spread over a wide area, reaching even to the opposite side of the abdomen. It may or may not be associated with local tenderness and muscle spasm. It is usually little influenced by posture. Occasionally there may be temporary radiation, not of a colicky nature, to the groin, the lower or upper abdomen, the opposite kidney region, or even the homolateral scapular region. Very infrequently, in acute inflammatory conditions, the pain may be throbbing. Constant pain may coexist with colic, occupying the intervals between the colicky attacks.

Among the lesions especially apt to give constant renal pain are pyelitis and pyelonephritis, pyonephrosis, perinephric inflammation or abscess, hydronephrosis, renal calculus, renal tuberculosis, and the peculiar condition known as nephralgia. Renal neoplasm is usually painless in its earlier stages, while any of the others, especially renal calculus, may remain painless for long periods, or even until the entire kidney is destroyed. Renal neoplasm may give constant pain in the later stages, and colic when hematuria or detachment of tumor fragments occurs. Occasionally compensatory hypertrophy of a sound kidney is associated with some aching pain, so that if the diseased kidney is painless, the only pain experienced by the patient may be on the healthy side.

Other pains especially apt to be felt in the costovertebral angle and loin are from spinal arthritis or muscular strain, nerve root pains in the lower dorsal region, retrocæcal appendicitis, posterior diaphragmatic pleurisy and splenic lesions.

Pains from abdominal viscera, as the gall-bladder, stomach, etc., may be so diffused as to give rise to confusion. Referred pains from the prostate are also felt here.

Renal (or ureteral) *colic* is the type of pain especially associated with lesions of the ureter. It is due to spasmodic contractions of the ureteral or pelvic muscles. These contractions may be called forth by the passage through the ureter of calculi, blood-clots, tumor fragments, parasitic cysts, or ureteral instruments (catheters, bougies, bulbs, etc.) by the introduction of irritant substances, or occasionally as the result of inflammatory lesions of the ureteral wall. They may no doubt occur in neuropathic subjects without special cause. Colic seldom results from efforts of the ureter to overcome simple obstructions, as strictures. Bodies of considerable size, as calculi, blood-clots, etc., may, however, pass through the ureter without colic. Since colic depends upon muscular contraction, it varies with the degree of irritability, and may, therefore, be much more severe in certain individuals than in others, or in the same individual at one time than another.

Renal colic is often of extreme severity, completely prostrating the patient. It is very often characterized by definite radiation, which is usually along the course of the ureter, extending to the external genitalia (penis and scrotum in men, vulva in women) or down the homolateral leg. In other cases the radiation is upward from the groin to the kidney region, or it may extend across the body or to the scapular region. The point of origin of the pain corresponds roughly to the location of the irritating body, and a patient may thus be able to follow the passage of a stone down the ureter. Upward radiation, therefore, is more apt to follow if the irritating body is in the lower part of the ureter.

Colic is often accompanied by nausea, vomiting, constipation, distention, and retraction of the testis. There may also be muscle spasm of the abdominal wall.

A recent patient, with a calculus caught in the ureter about 3 inches above the bladder was in constant pain until a catheter was passed up the ureter well beyond the calculus. As long as the catheter remained *in situ* (twenty-four hours) he was free from pain, but it returned immediately on removal of the catheter. This would seem to prove that the colic was produced not by spasmodic contraction of the ureteral muscle upon the calculus—for after the insertion of the catheter the ureteral wall was more distended than before—but by the back pressure of obstructed urine, which was relieved by the retained ureteral catheter.

We have seen 1 case in which a ureteral calculus about the size of a small cigar had been in the middle third of the ureter for about ten years without producing pain or colic. When removed it was found to be tunnelled, so that there was no obstruction to the passage of urine.

A stone lodged in the intramural or juxtavesical portion of the ureter may give a pain complex, characterized by ureteral colic, pain on urination, defecation, and ejaculation. This "complex" which we[1] described in 1907 is surely due to the intimate association between the ureter in its terminal portion and the seminal vesicle, vas, rectum, and bladder.

Colic is especially characteristic of ureteral calculus, though it may occur in any lesion causing hemorrhage, as renal calculus, tuberculosis, and neoplasm. It is very frequent following ureteral catheterization, and especially if irritant drugs have been introduced.

[1] Young: Transactions of the American Association of Genito-Urinary Surgeons, 1907, ii, 104–109.

Renal colic is almost unmistakable in its usual form, but, especially if it originates in the lower portion of the ureter, and is accompanied by muscle spasm, it may be taken for appendicitis, pelvic inflammatory disease, or other abdominal lesion. Since it is usually accompanied by hematuria, examination of the urine in doubtful cases is most important.

Vesical pain may be divided into that felt directly in the hypogastric region, and referred pain, which is usually felt along the course of the urethra or at the end of the penis. Thus infants often grasp the penis during a paroxysm of bladder pain. It is also characteristic of bladder pain that it may be constant, or appear only during the act of voiding. Constant pain may be much increased at the time of voiding. Emptying the bladder may relieve the pain for a time, but if the bladder is very irritable, spasmodic contractions may occur while it is empty, causing pain, which may be relieved after a small quantity of urine enters.

In general, bladder pain depends upon an infiltration, inflammatory or neoplastic, of the vesical wall (submucosa and muscularis). The pain due simply to a distended but otherwise normal bladder, as in retention of any sort, is less important. Occasionally a very superficial cystitis may be painless, but, on the other hand, a small area of interstitial or submucous cystitis may cause almost unbearable pain. The infiltration lessens the elasticity of the bladder wall and increases its irritability. At first this causes pain only on the muscular contraction which accompanies voiding, but later the increased irritability causes frequent or almost constant spasmodic contraction of the bladder, with continued pain. Bladder pain is usually but not always accompanied by frequency of urination. When retention occurs, the pain is greatly increased.

The mildest type of bladder pain is generally described as a "burning" on urination, often referred to the urethra and difficult to distinguish from that due to posterior urethral lesions. This may become stinging or lancinating in type. In more severe cases, the pain is also felt over the bladder region, and may become constant, persisting, usually in diminished intensity, during the periods between voidings. As the bladder wall becomes more inflamed, the muscular irritability increases, so that small amounts of urine cause a desire, often painful, to void, and frequency ensues. In severe cases, spasmodic contractions are produced which are extremely painful, and may persist some time after voiding is completed. This is known as tenesmus or strangury. The violent contractions may cause the inflamed areas to bleed, giving a terminal hematuria. When associated with great frequency, tenesmus may be mistaken for a true incontinence. The distress of such patients is extreme.

The severity of bladder pain depends only roughly on the size of the lesions. A small area of submucous cystitis or neoplastic infiltration may cause the greatest pain, while very extensive simple chronic cystitis may be painless.

The conditions almost always associated with bladder pain are acute cystitis, submucous (interstitial) cystitis, and tuberculous cystitis. Pain may or may not be present in vesical calculus, chronic cystitis, trigonitis, and foreign bodies. Tumor is painless in the early stages, but when cystitis and infiltration of the bladder wall occur, pain may be extreme. In obstruction there is usually little pain unless complete retention or cystitis occurs. Diverticula do not cause pain, but the associated conditions of cystitis, calculus, or obstruction often make the condition painful. The pain of calculus depends roughly on the size and roughness

of the calculus, and on the associated cystitis. Thus a small smooth calculus in an uninfected bladder may be painless.

Since bladder pain often accompanies cystitis, it is important to remember that cystitis seldom occurs without some other predisposing lesion, as obstruction, stone, tumor, diverticulum, tuberculosis, pyelitis, prostatitis, etc., and the ultimate cause of bladder pain should always be sought for.

Bladder pain may be caused by lesions which produce pressure on the bladder, as extravesical tumor, uterine tumor, rectal tumor, etc., by localized peritonitis, by dislocation of the bladder into a hernia or cystocele, etc. Few other pains simulate bladder pain.

Sensitiveness to foreign proteins may exceptionally cause a localization of allergic symptoms in the bladder, with painful urination, but with clear and sterile urine.[1]

Urethral pain is usually burning, stinging, or lancinating. It is often present only during voiding and may be hard to distinguish from referred bladder pain. The absence, in purely urethral pain, of accompanying frequency is an important diagnostic point.

The pain may be felt in the perineal region, or along the penile urethra. The point of greatest intensity often seems to be situated in the glans penis, regardless of the point at which the pain originates.

Urethral pain occurs in acute urethritis, chronic urethritis, urethral calculi, etc. Urination is usually somewhat painful in acute urethritis, but while this pain may be severe, it usually diminishes or disappears in the later stages of the disease. The most severe grades of pain are seen when the peri-urethral tissues are involved, as in the spongeitis which produces chordee.

Prostatic pain is most frequent in prostatitis. It is always present and severe in acute prostatitis, and may be present or absent in chronic prostatitis. Hypertrophy and carcinoma are not especially painful, but when carcinoma has invaded other structures it may cause great pain, often simulating sciatica. In any condition causing enlargement of the prostate or fibrous contraction of the prostatic urethra, bladder pain due to obstruction and infection may be superadded.

The pain of acute prostatitis or abscess is not apt to radiate, and is usually felt in the perineum or rectal region. It is burning, aching, lancinating, or throbbing. If retention occurs, the vesical pain therefrom may dominate the picture. The prostatic pain is similar to that due to perirectal abscess, to periprostatic abscess, or to perineal peri-urethral abscess or extravasation.

Chronic prostatitis may be painless, or may give the greatest variety of pains and abnormal sensations. Thus, feelings of "uneasiness," "pins and needles," warmth, coldness, etc., may occur in the perineum. Very often the pain is referred, and the points of reference may be, as we remarked years ago, "anywhere below the diaphragm." The table on page 197 of Vol. I shows how widely distributed the pains of prostatitis may be. Referred pains from prostatitis are often increased in the morning, just before and after arising, and wearing off during the day. This is a diagnostic point of considerable importance.

Owing to the wide distribution of prostatic pain it may be confused with many other conditions. Among them are spinal arthritis, sacro-iliac disease, sciatica,

[1] Duke: Journal of Urology, 1923, x, 173, 174.

appendicitis, gall-bladder disease, renal colic, etc. The resemblance to renal colic may be increased by the presence of blood in the urine from an inflamed posterior urethra accompanying prostatitis.

There should also be noted a condition of painful prostate or neuralgia of the prostate which may give severe pain with little or no local findings. This pain may be localized or referred, as in prostatitis.

Perineal pain not associated with prostatic disease is usually the result of local inflammation, which is sufficiently obvious that no diagnostic difficulties are encountered.

Scrotal pain may be due to disease of the scrotal contents and cord or may be referred from kidney, ureter, or prostate. Pain arising in the testis, as from a blow or acute inflammation, has the well-known sickening character, often with radiation upward into the groin. The peculiar quality of this "gonad pain" is usually recognized at once by male patients. Acute epididymitis causes very severe pain and tenderness. Varicocele may cause dull, aching pain or a "dragging" sensation. Adhesions or cysts of the tunica vaginalis may produce a dull "aching" pain which is very distressing. Many lesions of the scrotal contents are usually painless. Among them are neoplasm of the testis, syphilis of the testis (gumma or fibrosis), and hydrocele. Tuberculosis is often painless, but, especially in the acuter forms, may cause pain like that of epididymitis.

Occasionally there is persistent pain, the cause of which is not apparent. When not a referred pain, this is often due to adhesions, usually the result of an old epididymitis, between the testis and epididymis. This condition is sometimes spoken of as "painful testicle" or "neuralgia" of the testis.

One must always distinguish carefully between referred pain and local pain, and this often requires much skill.

DYSURIA

Dysuria is defined as painful and difficult urination. The term, therefore, is somewhat indefinite, and is no doubt used by various persons with slightly different meanings. It dates from a period when urologic knowledge was less clear than at present, and when it was noted that all painful urination was associated with straining and the sensation of difficulty, which is true even when no actual obstruction is present. It is perhaps better to specify, in referring to such conditions whether there are merely pain and straining (painful voiding) or whether there is an actual obstacle to the emission of the urine (difficult voiding).

In some cases, however, even where there is a partial obstruction to urination. if of very slow development, hypertrophy of the bladder may allow voiding to be carried on for a long time without pain or difficulty.

The conditions giving rise to bladder pain have been discussed above. When this pain is at all severe, the bladder muscles may contract spasmodically, increasing the pain. The spasm may extend to all the neighboring musculature of the lower urinary tract, including the sphincter, which produces a transient and functional obstruction. The patient therefore strains with his abdominal muscles to try to empty the bladder and bring the painful process to an end. The clinical picture does not differ markedly from that caused by true infravesical obstruction, and it is necessary to discover, by examination and by determination of the presence of residual urine, whether true obstruction exists.

The situation is further complicated by the frequent presence of cystitis in obstructive conditions, so that the symptoms of the two conditions are superposed.

The dysuria due to *acute cystitis* is usually obvious enough, and its short duration is further evidence of its uncomplicated nature. It is associated with frequency.

In *chronic cystitis*, unless of the mild painless type, there is also dysuria, running parallel to the pain, which again depends on the depth and severity of the inflammation. It may be at its worst in submucous or interstitial cystitis when the epithelium may not be broken and the urine is clear. It is also very marked in tuberculous cystitis. In all forms of chronic cystitis, however, it is apt to be complicated at any time in the later stages by true obstruction from cicatricial contraction of the vesical orifice, due to involvement of that region in the inflammatory process. The obstruction there aggravates the cystitis, making a vicious circle, and unless the obstruction is relieved, the physician cannot hope to cure the cystitis.

Difficulty of urination, accompanied by more or less pain, occurs when there is a true *infravesical obstruction*. The character of this difficulty depends partly on the location of the obstruction, and partly on the rapidity with which it develops. In general, obstructions at the vesical orifice are of slow development (prostatic hypertrophy, carcinoma of the prostate, contracture of the vesical orifice, carcinoma of the bladder, etc.). Exception to this rule is when a partial obstruction due to one of the above lesions is suddenly transformed into a complete obstruction by edema and congestion, or when a pedunculated tumor, calculus, or other body suddenly drops into the urethral orifice. This produces the most extreme form of difficulty, namely, acute retention. The most violent expulsive efforts expel no urine, and the distention of the bladder produces great pain. If not relieved, either by some form of instrumentation or spontaneously, urinary secretion may cease. If the obstruction does not reach the stage of complete obstruction, there is gradual increase of difficulty and pain, and urination becomes more and more frequent.

Obstructions lower in the urethra, which are usually due to urethral stricture, also produce difficulty. This difficulty is distinguished from that due to prostatic obstructions in three principal features: (1) There may be little or no frequency associated; (2) there is marked diminution in the size of the stream, and (3) voiding is followed by a dribbling of urine from the meatus for some little time. The first two features are due to the comparative inelasticity of the stricture, which while it may obstruct the flow of urine by decreasing the aperture of the urethra, yet allows the bladder to be entirely emptied if expulsive efforts are continued long enough. Therefore, there is often no frequency. Prostatic obstructions, on the other hand, are more elastic, and while they resist the passage of urine, yet when this resistance is once overcome, the stream is of fair size, since the size of the urethra is not actually reduced. Toward the end, the muscle fibers contracting with less force, the elastic obstruction closes the urethra again, before the bladder is empty, resulting in residual urine, and frequency develops. With the inelastic stricture, the bladder, after long or even repeated efforts, can empty itself, though the stream be small and slow, completely. The third feature, dribbling, occurs because that part of the urethra lying above the stricture is usually dilated by the great expulsive force necessary. After the bladder is empty, the urine contained in the dilated urethra gradually escapes through the stricture, producing dribbling.

The dysuria of stricture may increase to the point where the urine can only be voided in drops. In these extreme cases there may be vesical distention, great pain, and even urinary suppression due to back pressure.

HEMATURIA

Hematuria, while sometimes neglected by the patient, usually alarms him and sends him to the doctor. Exception must be made, however, for cases in which the blood is in amount insufficient to discolor the urine, and discoverable only by microscopic or chemical tests. When the blood is present in greater quantities, it may be distributed through the urine, giving it a smoky or even a red color, or it may coagulate in the ureter or bladder, and be expelled in the form of clots.

Women are more apt to ignore hematuria than men, since they are accustomed to see blood mixed with the urine during menstrual periods. Unfortunately, physicians sometimes treat hematuria expectantly. This should never be done, as in a great majority of cases, blood in the urine indicates a serious disease.

Some idea of the *source of the blood* can be gained by examination of a three-glass specimen of urine. If the bleeding is from the urethra distal to the external sphincter, the blood will flow from the meatus independent of voiding, the first glass of the urine specimen will be stained, while the second and third will be comparatively clear. If the source is in the urethra above the external sphincter, there will be no bleeding between voidings. The first glass will contain blood, while the second and third will be clear, provided the bleeding is moderate in amount. If in sufficient quantity to fill the posterior urethra and find its way into the bladder between voidings, the second and third glasses will also be blood stained. If the bleeding is from the prostate, or from granulations or polyps in the posterior urethra, but small in amount, it may not flow back into the bladder, in which case the first glass will be bloody. The third glass may be more heavily charged with blood than the second, owing to the compression exerted at the end of urination by the muscles emptying the urethra.

Blood coming from *above the vesical sphincter* is usually thoroughly mixed with the bladder urine, whether its source be in the kidneys, the ureters, or the bladder, and the three glasses are therefore equally colored. The classical statement that a terminal increase (at the end of voiding) in the amount of blood indicates a bladder origin for the blood, is too inaccurate to be of any value, since blood of renal origin may collect in the base of the bladder and discolor the third glass more than the second. Also, blood of vesical origin may be distributed equally among the glasses. It is, however, true that in some cases the final contraction of the bladder muscle squeezes some additional blood from a tumor or other lesion, causing the typical "terminal" hematuria—sometimes to the extent that a few drops of blood unmixed with urine are expelled at the end of voiding.

The only diagnostic points that can be relied on when all three glasses are blood stained are, first, the presence of the worm-like *ureteral casts* of blood-clot, which are pathognomonic of bleeding above the bladder, and, second, the presence of *blood casts* or cylinders, which are pathognomonic of bleeding from the renal parenchyma. It should be remembered that the introduction of a ureteral catheter may cause traumatic bleeding. Blood in a ureteral catheter specimen does not, therefore, necessarily indicate the source of a hematuria. The proper investigation of any case of hematuria, then, includes endoscopy and cystoscopy, and con-

tinues until the source and cause of the bleeding are established beyond doubt. Observation of the jets of urine ("ureteral meatoscopy") is often more valuable than catheterization in determining the source of blood.

Bleeding from the *kidney* or *ureter* always indicates a lesion of importance. Among those causing hematuria are acute nephritis, either infectious or toxic, renal tuberculosis, renal and ureteral calculus, renal or ureteral neoplasm, hydronephrosis, traumatism, and infarct of the kidney. There is also the condition known as essential hematuria, in which bleeding occurs from a kidney in which no lesion can be discovered. It can only be diagnosed by exclusion, and before making such an unsatisfactory diagnosis, the exclusion should be most thorough and rigid. Temporary bleeding from the kidney may follow the sudden emptying of a chronically distended bladder. Renal hematuria, then, is never negligible, since even the cases in which the diagnosis of essential hematuria has to be made may lose enough blood to endanger life.

Bleeding from the *bladder* likewise is practically never negligible. The principal causes are acute cystitis, calculus, tuberculosis, neoplasm, submucous or interstitial cystitis, benign prostatic hypertrophy, and carcinoma of the prostate. In the two last the bleeding occurs from the congested surfaces of intravesical growths, or from the urethra, and is more frequent in the benign cases than in those of carcinoma. Bilharziosis is a frequent cause of vesical hematuria in infested countries. There are also the cases in which hematuria follows the sudden emptying of a largely distended bladder. This bleeding is temporary.

In cases of bleeding from above the vesical orifice, the following maxims, showing the lesions most likely to be present, are of use. They are not infallible, however.

TABLE 152

Blood.	Pus.	Bacteria.	Probable diagnosis.
+	0	0	1. Neoplasm. 2. Calculus. 3. Nephritis, acute.
+	+	0 (t. b. excepted)	1. Tuberculosis. 2. Occasionally calculus.
+	+	+	One of the above secondarily infected, or cystitis.

Bleeding from *below the vesical sphincter* may come from acute or chronic urethritis or prostatitis, urethral polyps or neoplasms, urethral calculus, urethral varices, tuberculosis of the urethra or prostate, and traumatism. Urethral bleeding from carcinoma of the prostate is very rare.

One must exclude the occasional cases of hemoglobinuria (paroxysmal or other). This is done by combining microscopic and chemical tests. If the chemical tests (guaiac or benzidin) are positive, and no red blood-corpuscles can be seen in the sediment, we are dealing with hemoglobinuria. In methemoglobinuria, hematoporphyrinuria, melanuria, etc., the color is distinct from that of blood, and the same is true of the bile-stained urine of icterus.

FREQUENCY OF URINATION

Frequency of urination may occur in three quite different ways: (1) The capacity of the bladder may be reduced by muscular hypertrophy, cicatricial contrac-

tion, intravesical calculi or tumors, or pressure from the outside, so that it cannot contain the normal quantity of urine, and must be emptied more frequently; (2) a partial obstruction below the bladder may produce a residual urine. The bladder may then contain, over and above the residual, only a small quantity, and must be emptied more frequently than normal; and (3) the irritability of the bladder may be increased by inflammation or neoplastic infiltration, so that the desire to void arises more frequently and more imperiously than normal. More than one of these causes may be present in the same case, the combination of 2 and 3 being the most frequent.

In cases where there is doubt as to whether a frequency is due to increased irritability or to a true cicatricial contraction, the question can be answered by determining how much fluid (at a head of about 6 feet of water) can be introduced in the bladder, first, with the patient conscious, and, later, under a general anesthetic. If the bladder capacity is reduced while conscious, but normal while anesthetized, we may conclude that the frequency is due entirely to irritation. If the bladder capacity is reduced while conscious, and no greater while anesthetized, we may conclude that the frequency is due entirely or almost entirely to a true contracture of the bladder. If the bladder capacity is reduced while conscious, and greater, but still subnormal, while anesthetized, there are both contracture and increased irritability. The lesions in which such situations arise are especially tuberculosis of the bladder, submucous (interstitial) cystitis, and carcinoma of the bladder.

In infravesical obstructions cystitis is very often present, adding an irritative element to the frequency. For this reason the frequency cannot be depended on to run parallel to the amount of residual urine. There may be marked frequency with a small residual and an hypertrophied (small) bladder, while in other cases with dilated and atonic bladder, and very large residual, urination may take place at almost normal intervals. The frequency does run parallel, however, with the difference between the residual urine and the bladder capacity (BC—RU); that is, the nearer the residual urine approaches the bladder capacity, the greater the frequency.

Especially when there is an irritative element (cystitis or posterior urethritis), the desire to void is often much stronger than normal. This is called *urgency of urination*. When the bladder contracts so strongly that the desire to urinate cannot be resisted at all, or at best only for a few moments, it is called *precipitancy of urination*. In these conditions there is practically always frequency.

The beginning of frequency may be difficult to determine exactly. No dogmatic figures can be given, since the normal interval varies so much. Some individuals only empty the bladder twice a day, while others, owing to a congenitally small bladder, habit, unusually large fluid intake, or a neurosis, void much more frequently. If the quantity voided each time is a normal one, there is not a true frequency, but a polyuria or increased quantity of urine. Many men, from the age of forty years on, get up once at night to urinate. More important than a history of frequent voiding is the measure of the quantity ordinarily expelled. In diabetes insipidus or mellitus urination may be very frequent. If the frequency is accompanied by pain, difficulty, hematuria, or pyuria, there can be little doubt about it.

As frequency increases, it is sometimes accompanied by urgency, precipitancy, or tenesmus, depending on the cause. In the ultimate stage of frequency, voiding

becomes practically constant. This condition must be distinguished carefully from true incontinence, due to relaxation or injury of the sphincters, and one must also determine whether the condition is caused by a very irritable bladder, in practically tonic contraction, or by an obstructed bladder in which the bladder capacity and residual urine are the same (BC = RU), so that there is no room for any urine to collect there. This last state is known as "paradoxical incontinence"; an incontinence due generally to obstruction.

The frequency occurring in bladder paralysis is of the type due to a large residual urine, and may go on to paradoxical incontinence. Thus, in bladder trouble due to disease of the central nervous system, there may be paradoxical incontinence while the sphincters are still functionally potent, as well as true incontinence after they are relaxed. Where bladder sensation is abolished, it may be found that a supposed incontinence, in which the clothing or bed is frequently found wet, is really an automatic frequency. (For full discussion see the chapter on Physiology and Pathology of Micturition.)

Frequency is often the first sign of urologic disease, and while mild forms may be ignored, the severer grades incapacitate patients completely, and cause the greatest distress. Thus a person who has to void every twenty minutes or so is unable to work except with difficulty, and is deprived of most social enjoyments.

Frequency in old men is especially suggestive of *prostatic obstruction*, and is apt to be more marked at night (nocturnal frequency). It must be distinguished from the nocturnal polyuria of *nephritis*, but there may also be a nocturnal polyuria in the obstructive nephropathy. One of our patients passed ten times as much during the night as in the day. The simplest sure way to rule out prostatic obstruction is to determine with a catheter if residual urine be present.

Frequency in younger individuals may mean *acute posterior urethritis*, *acute cystitis*, *submucous cystitis*, *diverticulum*, *congenital valves*, *bars* or *strictures*, *vesical calculus*, or *tuberculosis*. It may occur in *pyelitis* or *hydronephrosis*. In women *trigonitis* or pressure of the uterus is often the cause, though pyelitis must be ruled out. Frequency and hematuria commencing simultaneously, or almost so, suggest tuberculosis strongly. Frequency occurs in so many different conditions, however, that only a thorough examination with cystoscopy can be relied on to disclose the cause in most cases.

ALBUMINURIA

While albuminuria is of less significance than other elements in urologic diagnosis, its interpretation is complicated when blood or pus is present in the urine. Both blood and pus must be absent before one can be sure that the albumin present really comes from the renal parenchyma. If either blood or pus be present, there will always be albumin. In the case of blood it may be possible to estimate, after counting the red cells in a cubic millimeter of urine, the amount of albumin which should be present if the plasma of the extravasated blood is alone responsible for it.[1] With pus, however, no such constant relation exists. When white blood-

[1] There are about 75 gm. of protein in 1000 gm. blood. If, for example, in a given case, the circulating blood contains 5,000,000 red blood-cells per cubic millimeter, and the urine 50,000 red blood-cells per cubic millimeter, the urine then contains 1 per cent. of blood or 10 c.c. of blood to the liter. One c.c. blood contains 0.075 gm. protein. This urine, if otherwise albumin free, should contain 0.75 gm. of protein (practically 0.8 gm.) per liter on account of the blood present in it.

corpuscles pass from an inflamed or raw area into the urine, they may be accompanied by a greater or less quantity of serum, as from any other discharging surface. The protein of the pus cells themselves, if they are present in great numbers, is precipitated during the test and goes to swell the total. We may, therefore, only guess roughly, as, for example, when there is much albumin and only a few pus cells, that part of the albumin is coming from another source.

Renal albuminuria occurs in many surgical conditions of the kidneys as it does in Bright's disease, for example, pyelonephritis, tuberculosis, hydronephrosis, etc. Since pus may account for an indefinite quantity of albumin, albuminuria does not provide a reliable means of distinguishing pyelitis from pyelonephritis. Albuminuria may occur in cases of chronic urinary obstruction. Both albuminuria and hematuria may occur after the sudden release of an obstructed kidney by draining the bladder or ureter.

In certain cases, there is a paroxysmal albuminuria, known as orthostatic or postural albuminuria, which occurs usually when the patient is in any position which exaggerates the lumbar lordosis. Standing often suffices to do this. These cases can be detected by examining urine taken immediately after several hours rest in bed, which will, in this condition, be albumin free.

In a word, albuminuria does not necessarily, in a urologic patient, indicate Bright's disease and much more refined methods must be used before this diagnosis can be made in such a patient. (See the chapter on the Obstructive Uropathy.)

BACTERIURIA

The study of the bacterial content of the urine has been neglected in the past, but is one of our most important diagnostic aids. It is carried out by means of stained smears of the sediment from centrifugalized urine, by cultures, and in the case of the Bacillus tuberculosis and a few rare organisms, by animal inoculation. For ordinary purposes a methylene-blue stain of the dried sediment suffices, and should be a routine part of every urine examination; for the tubercle bacillus, the Ziehl-Neelsen or other suitable staining method is used, while for the gonococcus the Gram stain is necessary, and is also best for general purposes.

One attempts to learn roughly the number of bacteria present, the quantitative relation with the pus present, the kind of bacteria, and the source from which they come.

The search of urethral smears for Gram-negative diplococci is familiar to everyone. The urinary sediment is studied in the same way. If, for example, we find the symptoms of a severe cystitis with urine free from pus and bacteria, the diagnosis of submucous cystitis is almost certain. If we find the symptoms of a severe cystitis with urine containing pus, but no organisms in the ordinary preparation, we suspect tuberculosis (or sometimes calculus). If we find the symptoms of a severe cystitis with urine containing much pus and many bacteria, we may be surprised to find the urine from a ureteral catheter containing pus but no bacteria, and pointing to a renal tuberculosis as the basis of the patient's trouble.

Bacteria may, however, be present in such small numbers in the urine (and also in prostatic secretion) that they are missed in smears, but appear in cultures. It is for this reason that cultural studies of the urine are so important.

The bacillus of tuberculosis must be sought diligently whenever there is any suspicion of this disease. The urine is thoroughly and repeatedly centrifugalized,

the sediment stained, and the smears examined with care. If the bacilli are not found, some of the sediment is injected intraperitoneally in a guinea-pig. Lesions develop in the pig, usually in the retroperitoneal lymph-nodes, within two to four weeks.

In examining for the gonococcus, the Gram stain should always be used, as Gram-positive staphylococci may take on the form of biscuit-shaped diplococci exactly like gonococci. Where the point is important, cultures and the sugar reactions should be made, in order to identify the gonococcus beyond all doubt, as the Micrococcus catarrhalis and other Gram-negative diplococci (pseudogonococci) are occasionally found in the urethra or urine.

The types of bacteria occurring in the various lesions are fully discussed in the chapter on the Bacteriology of Urogenital Infections.

A special condition of interest here is that known as bacteriuria without pus. The bacteria apparently reach the urine through the kidney from the bloodstream, and in some cases seem to multiply in the bladder without causing any cystitis. They may be present in such numbers as to make the urine turbid; a peculiar shimmering turbidity which resists centrifugalization. It will usually be found, however, that such cases will eventually show the signs of pyelitis. In such cases we have found bacilli of the colon group, pseudodiphtheria bacilli, and various cocci.

PYURIA

Pyuria is of great diagnostic significance, but is often ignored by patients. In other cases they are alarmed by mistaking a cloud due to phosphates or carbonates for pus. In the case of a turbid urine the presence of pus should always be confirmed by microscopic study.

The three-glass test is of especial value in helping to determine the source of pus in the urine. The following table summarizes the information which can be drawn from the three-glass test. It will be noted that in some cases the presence of more pus in one glass than in another is of significance.

TABLE 153

Glass. Pus.	The pus is from:	Probable diagnosis.
G. I. ++ II. 0 III. 0	Anterior urethra.	Anterior urethritis.
G. I. ++ II. 0 III. +	Urethra and prostate.	Prostatitis.
G. I. +++ II. + III. ++	Prostate or posterior urethra.	Prostatitis, Posterior urethritis.
G. I. + II. + III. +	Bladder, Kidneys.	Pyelitis, Cystitis (tuberculosis).

It will be seen that while very definite information, in most cases, can be gained by this test as to whether the pus comes from above or below the vesical sphincter, it is of no value in distinguishing whether the source is from the bladder, kidneys, or ureters. This must be determined by cystoscopy and ureteral catheterization.

The specimens from the two kidneys are examined separately. The traumatism of the catheter, while it may produce a few red blood-corpuscles and epithelial cells, never causes the presence of pus cells. By pushing the ureter catheter farther up the ureter the blood sometimes disappears in the catheterized specimen.

Pus can occur in the urine only as the result of inflammation, either from infection or chemical damage. The infection is in the urogenital tract except in those cases where an abscess ruptures into the tract from some other organ. Pyuria therefore indicates an inflammatory condition, but it must not beforgotten that this inflammatory condition is often complicated by some other lesion, especially stone, neoplasm, or obstruction.

Since in a great majority of instances pus is the result of an infection, it will usually be accompanied by the causative bacteria. Exceptions to this rule are the inflammations caused by chemicals, and in tuberculosis, where the Bacillus tuberculosis is sometimes absent or at least not demonstrable. The same is true of the rarer granulomatous lesions, as syphilis and actinomycosis. In these cases, the absence of all bacteria from the pus-containing smears is a very important diagnostic point. In other words, pus without bacteria always suggests tuberculosis, though, of course, the positive diagnosis can be made only after the detection of the Bacillus tuberculosis.

Where pus comes from below the vesical sphincter, further localization is accomplished by means of the urethroscope (sometimes by obtaining secretion from the ducts of Littré, Cowper's glands, utricle, or ejaculatory or prostatic ducts) or by prostatic massage with examination of the secretion.

When pus comes from above the vesical sphincter, one thinks, in all but acute cases, of some complicating lesion, since chronic cystitis seldom occurs without other cause. If there be no paralysis, obstruction, tumor, or vesical calculus, a cystitis may be kept up by a renal infection (pyelitis or pyelonephritis) or by a chronic prostatitis, vesiculitis, posterior urethritis, or utriculitis. In the same way, tuberculous cystitis practically always depends upon renal, prostatic, or vesicular tuberculosis—the former much more frequently than the latter. Indeed, it is safe to say that in any case of persistent pyuria, the kidneys should be ruled out by ureteral catheterization.

Of lesions predisposing to cystitis may be mentioned calculus, tumor, bladder paralysis, and the following causes of obstruction: benign prostatic hypertrophy, carcinoma of the prostate, contracture of the vesical orifice, congenital valves of the urethra, and urethral stricture. Cellules and diverticula, resulting from obstruction, predispose to infection, and favor its persistence. Tuberculosis is often complicated by secondary infection with other bacteria. Acute gonorrheal urethritis is sometimes complicated by an acute cystitis. Normal bladders may become infected by instruments, as in postoperative catheterization, but usually clear up quickly. Submucous (interstitial) cystitis, being entirely beneath the epithelium (generally), does not cause pyuria, the urine remaining entirely clear unless secondarily infected (or bloody).

Renal infection (pyelitis and pyelonephritis) may occur spontaneously, the organisms coming from the blood-stream, or may be precipitated by the presence of a calculus or of an obstruction. Hydronephroses are apt to become infected. Renal tuberculosis may become secondarily infected by ordinary bacteria. Renal neoplasms usually do not give pyuria. Pus may be absent from the urine in peri-

nephric abscess, or in any other inflammatory lesion, as pyelitis, pyelonephritis, pyonephrosis, or tuberculosis, when the ureter from the affected kidney is completely blocked.

DISTURBANCES OF THE SEXUAL FUNCTION

The disturbances of the sexual function which are so common in association with prostatitis, vesiculitis, and neuroses have been fully discussed in the sections on Prostatitis and Vesiculitis (see Vol. I, pages 198, 210, 276).

Hematospermia may occur in prostatitis or tuberculosis and rarely in carcinoma or hypertrophy of the prostate. It is seldom noticed by the patients.

Azoöspermia may occur in congenital malformations of the genital tract, in hypoplasia of the testes, after bilateral atrophy of the testes, or as the result of bilateral obstructive epididymitis, stricture of the ejaculatory ducts, or other obstructive changes in the genital tract. It is the commonest cause of male sterility, although in some cases non-motile and non-viable spermatozoa are secreted in the semen. The cause of this azoöspermia may be inflammatory lesions of the vesicles or ampullæ, but in some cases the cause is not discoverable. Recent work showing that either male or female individuals may develop antibodies against spermatozoa, after intravenous or intraperitoneal injection of spermatozoa or semen, may throw some light on these cases.

In all cases of *childlessness*, the male should be examined as well as the female, and preferably first, as the examination is simpler. If no motile spermatozoa are found in the expressed prostatic and vesicular secretion, at least three fresh condom specimens, examined on the warm stage, should be studied before a diagnosis of sterility is made. In obstructive cases, efforts may be made to re-establish the lumen, or to inject into the uterus spermatozoa from the head of the epididymis, since in otherwise normal cases, viable spermatozoa are always found above the obstruction. If there is evidence of a prostatovesiculitis, active spermatozoa may appear after the infection has been controlled by appropriate treatment.

CHAPTER XIII

EXAMINATION OF THE UROLOGIC PATIENT

HISTORY

THERE is no department in medicine in which a complete, consecutive history of the development of the malady is of greater assistance or more important. We have space here to stress only a few items of special interest.

Complaint.—This should be a complete statement of everything of which the patient complains.

Family History.—In addition to the usual questions, the subject of family tuberculosis, cancer, and nervous diseases should be carefully considered.

Past History.—Infectious diseases such as measles, mumps, diphtheria, scarlet and typhoid fevers should be noted and the patient questioned as to genito-urinary sequellæ, remembering that many renal infections not infrequently start from these diseases. A history of tuberculosis should be thoroughly gone into, not only as regards the lungs, but also the glands, tonsils, bones, etc. Focal infections are of great importance and the condition of the patient's teeth, tonsils, nose, ears, sinuses, and intestinal tract may play an important rôle in the development and treatment of renal or prostatic infections.

Gonorrhea.—The date, character of onset, and treatment that was instituted for the acute infection should be carefully noted as well as the development of the disease, whether it became posterior or involved the prostate, seminal vesicles, bladder, epididymes, blood-stream, joints, heart, etc., as well as can be determined from the patient's statements. Complications resulting from gonorrhea lead to stricture, prostatitis with its multiplicity of symptoms—irritative, urinary, sexual, painful, local, referred, etc. If the patient married, what was the result as regards wife and children. The relation of sterility, if present, to previous gonorrhea is inquired into; a history of pelvic operations, miscarriages, stillbirths, etc., in the wife should be brought out, as well as the number of children and their state of health.

Syphilis.—Date of onset, appearance, and symptoms of initial lesion. Diagnosis. Were spirochetes found? Initial treatment during the primary stages. Were antiseptics used before the diagnosis was complete? How early was treatment begun—its nature and results? Did secondaries appear? If syphilis was the diagnosis and treatment was given, state the drug, dosage, results, subsequent treatment, other drugs, course of disease, and final result. Late manifestations—skin, bones, glands, etc., central nervous system, tabes, effect on sexual powers, micturition, defecation.

Chancroid.—Thorough questioning to elucidate whether the sore was syphilitic or the diagnosis of syphilis prevented by mercurial or antiseptic treatment. Careful notes of progress of the disease to detect history of secondaries or later lesions suggesting syphilis. Other local genital lesions should be likewise carefully brought out and their course depicted briefly.

Present Illness.—Function of genito-urinary organs. The patient should be

carefully questioned as to any disorders of urinary production, elimination, micturition; sexual powers, desire, ejaculations, impotency, sterility, etc. Urologic symptoms, accompanied with any of the aforesaid conditions, should be carefully noted. The general effect of the genito-urinary disease on general health, nervous system, cardiovascular, gastro-intestinal tracts should be noted, laying stress on the development of cardiorenal disease, arteriosclerosis, etc. The date of onset of present illness, its character, and symptoms should be carefully noted, together with the initial diagnosis, the treatment employed, effect, and sequellæ. The subsequent course should be followed systematically both as to symptoms, treatment, and results. Any important occurrences, such as sudden changes in symptoms and condition, should be brought out. Any attacks, crises or marked changes, especially those associated with fever, uremia, etc., should also be noted. Pains, their location, character, severity, radiation, treatment required, effect of treatment, frequency of recurrence, variations, intensity, etc., with progress of the disease, should be carefully recorded. As the disease progresses the effect upon the region involved, adjacent structures or regions successively invaded, with the systemic and remote sequelæ, should be given.

Special Remarks.—In acute infections with the gonococcus the progress of the disease, the depth and character of the invasion should be carefully noted. The onset of symptoms, involvement of the posterior urethra, prostate, bladder, seminal vesicles, epididymes, general circulation, heart, joints, etc., should be in the history. As the disease becomes subacute and then chronic, the symptoms due to chronic infiltration of the urethra, prostate, and other organs should be fully elucidated by the symptoms in the record. Chronic prostatitis with its complexity of irritative, painful, sexual, inflammatory, and obstructive symptoms should be thoroughly noted as well as chronic infections of the seminal vesicles and epididymes. Urinary infections are generally either descending—renal—in origin, or ascending—urethral and vesical. From the point of inception infection usually spreads up or down to other portions of the genito-urinary tract and the history should bring out in clear details the course of the disease, etiology, the treatment employed, the complications and results. The passage of instruments, catheters, sounds, etc., is often the beginning of an acute vesical inflammation. The onset with chill, fever, irritation, pain, etc., should be carefully noted as well as the subsequent progress and the invasion. With the development of pyelonephritis, loss of renal function and toxemia bring their train of local and systemic symptoms, uremia, gastro-intestinal symptoms, cardiorenal symptoms and pyrexia, chills, malaise, loss of weight, etc. The obstructive uropathy and its development should be brought out and careful record made showing the etiology, the initial symptoms, the development of complications in the urethra and bladder or ureter and kidney, the increase in vesical distress, changes in micturition, pain, fever, gradual diminution in renal function with its train of uremic and infectious symptoms, the changes resulting from treatment with catheters, dilators, sounds, prostatic massage, etc., and other forms of local treatment as well as internal treatment, antiseptics, etc., should be carefully recorded. The change from benign to malignant disease of the prostate may often be detected in the history which should be complete in its details as to pain, hemorrhage, metastasis, etc., and the symptoms and signs which accompany them. In diseases of the bladder changes in the frequency, force, character, pain, etc., of micturition are of great importance in the diagnosis, particularly of such

diseases as submucous cystitis, tuberculosis, and stone. Radiation of pain to the urethra and glans penis is noted, the latter being of diagnostic importance, particularly in children. The history of incontinence should be thoroughly detailed so as to differentiate between real incontinence and frequency of urination, paradoxical incontinence, or postoperative incontinence.

In a word, the history should be systematic, contain the development of symptoms, treatment, and results and end with a note on the *status præsens* in which a full outline of the present situation as to general health, urination, sexual powers, and functional condition of the upper urinary organs is adequately outlined.

EXTERNAL EXAMINATION

The urologic examination will naturally depend greatly on the history and character of the disease. In minor cases of little importance it is unnecessary and wasteful of time and effort to insist on too elaborate methods and histories. Every case, however, should be thoroughly studied so as to give complete, accurate, and full details on the condition present, the clinical impression, and treatment given. Where the case is one of considerable importance, full and elaborate details, necessary to record completely the clinical findings, the diagnostic data, the treatment instituted and results obtained, should be insisted upon. The language should be to the point and accurate and sufficient for a scientific record of the case. In no other department of medicine is the use of bacteriologic and chemical laboratories more immediately essential as in urology and full equipment should be at hand to carry out all necessary scientific investigations. The use of sketches and charts is particularly important in urology. Even rough diagrams and drawings of lesions of the penis, scrotal contents, rectal findings, urethroscopic and cystoscopic pictures greatly facilitate the description and explanation of the case. Regular diagrams of the prostatic examination and of the vesical orifice, trigone, and ureters as seen with the cystoscope are essential. Photographs of external lesions, *x*-rays—plain and shadowgraph—of the urethra, vesicles, vasa, bladder, ureters, and pelvis are necessary in appropriate cases. Accurate drawings, photographs, and models of lesions should be made of rare or interesting conditions. Functional studies of the kidney and blood, special examination of the cardiovascular and nervous systems and their relation to the urinary disease should be made in addition to careful general physical examination.

We have not the space to describe in detail the multiplicity of methods, instruments, and technic which have filled the pages of urologic journals and text-books. We have only attempted to describe the methods employed at our clinic, realizing perfectly that other methods worthy of description are omitted.

Physical Examination.—The patient usually strips. General physical examination may be done at this time, but is usually deferred until the patient is quiet in a hospital bed. The general physical aspect of the patient is noted, his strength and vigor. The arterial wall and pulse rate, perhaps the blood-pressure may be taken, but intimate details are left for studies in the hospital wards. While in the standing posture the abdomen is given a cursory examination, attempt is made to palpate the kidneys and detect mobility, enlargement, induration, tenderness, or other characteristics. With the thumb beneath the ribs in front and the fingers in the loin behind, it is usually possible to grasp the tissues beneath the kidney as in a caliper, and, as the patient breathes, to palpate the lower pole of the kidney and to

make out abnormal conditions. There is often sufficient resistance of the abdominal muscles or nervousness on the part of the patient to interfere with a careful examination of the kidneys, which is then left for the recumbent position. The prevesical region is palpated and percussed for vesical distention, tenderness, induration, etc. Sinuses or fistulæ in the renal or vesical regions are noted, if present.

Palpation and percussion in the kidney regions reveal undue tenderness. Masses connected with the kidney usually move downward on inspiration.

Genitalia.—This should be given in detail, *e. g.*, foreskin, length and retractibility; paraphimosis, balanoposthitis, ulcers, papillomata, and other lesions are noted. *Glans:* Its conformation, abnormalities (epispadias, hypospadias, aberrant ducts, stricture of the meatus, etc.). The *meatus* is carefully examined for discharge or gluing. If present, slide smears and perhaps cultures for the gonococcus on special media are made. The size, appearance, examination by palpation, percussion, transmission of light, etc., of the *scrotum* may be noted. The characteristics of the testicle; tunica vaginalis (hydrocele); epididymis—cysts, induration, adhesions, painful areas; sinuses of globus major, body or minor; vas—induration, nodules, beads, etc.; veins—varicocele, etc.; scrotal sinuses and fistulæ. *The groin:* Glands, sinuses, inguinal canal, herniæ, undescended testicles, etc., are noted. *Perineum:* Appearance, presence of induration, fistulæ, wounds, scars, or acute extravasation, inflammations, abscesses, etc., are noted.

Urine Collection.—The patient is required to void urine in three clean, conical glasses, each of which is then immediately examined for the presence of pathologic elements, *e. g.*, shreds, mucus, pus, general cloudiness, blood, tissue-particles, gravel, prostatic or vesicular secretion, etc. If cultures are desired the glans, meatus, and anterior urethra must be sterilized in order to remove the bacteria which commonly inhabit these regions. For this purpose, after fully retracting the foreskin, an alcohol sponge is vigorously applied to the meatus and glandular surfaces immediately surrounding it and the anterior urethra is then injected with 1 : 500 solution of meroxyl or 1 : 20,000 bichlorid of mercury. The patient is then instructed to void urine in a conical glass, care being taken to see that the sterilized areas do not become infected by the hand or instrument. As soon as a small amount of fluid passes (to wash out the antiseptic) the urine is caught in a sterile test-tube. In order to avoid contamination from the edges of the test-tube when the cotton stopper is removed, it is our custom to use only test-tubes the cotton stoppers of which have been covered with paper firmly bound by a string before sterilization. In removing the cotton stopper the physician should be careful not to touch the glass, else infection from his finger may occur when the urine flows down over the edge of the test-tube. If cultures from the prostate are to be obtained, *rectal examination* is now done, care being taken not to allow the penis to become contaminated. The fluid, forced out by stripping of the prostate, seminal vesicles, or ampullæ, is carefully collected in another test-tube. The corpora cavernosa and spongiosum, the urethra—penile and bulbar—are then examined by palpation for induration, abscess, fistula, etc.

Rectal Examination.—The condition of the anus, fissures, hemorrhoids, strictures, etc. Anal sphincter—strength, tonicity, flaccidity. Rectal wall, ulcerations, polyps, tumors; compression of rectal lumen by external lesions. Hypertrophy of the prostate, carcinoma, sarcoma, periprostatic inflammations, abscesses, fibrous infiltration, etc.

Examination of the *prostate* is done with the hand covered with a rubber glove or the finger covered with a cot (if possible, fortified by a rubber sheet or tissue paper to cover the hand). The prostate is very carefully palpated while the patient is in the knee-elbow position. In our opinion this position is far preferable to that

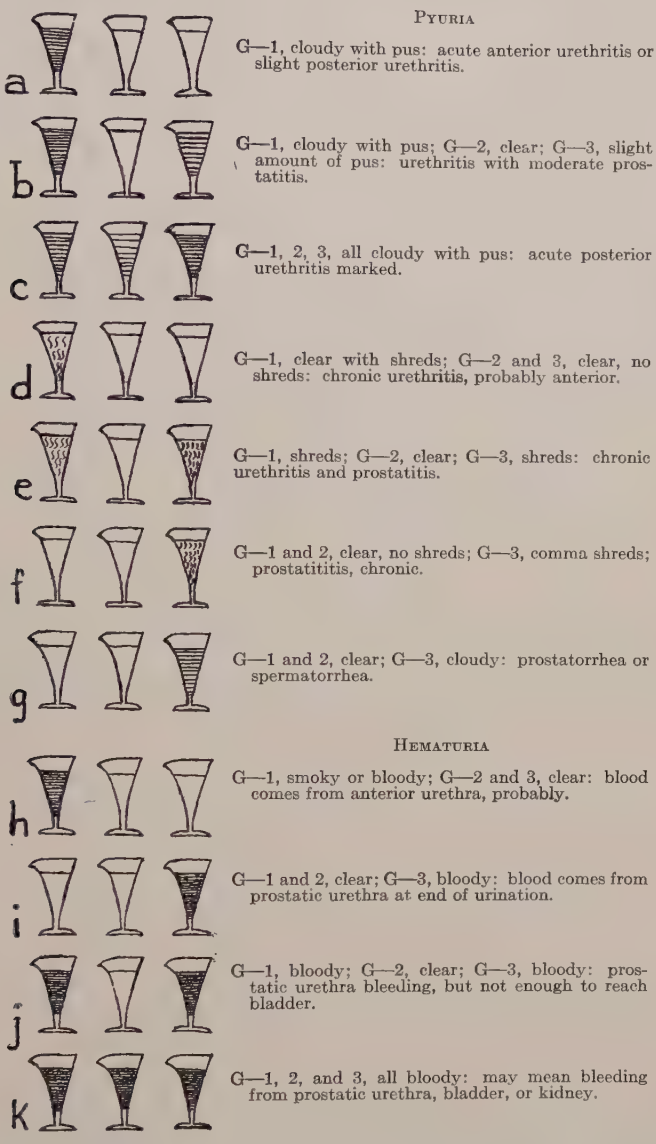


Fig. 623.—The three-glass test. In various forms of acute urethritis, *a*, *b*, and *c*; in chronic urethritis of different portions of the urethra or prostatitis, *d*, *e*, and *f*; in prostatorrhea, *g*; in hematuria the blood coming from various portions of the urinary tract, *h*, *i*, *j*, and *k*.

in which the patient leans over a chair or the edge of a bed or when he lies upon his back. Without using force the index-finger (of the left hand, usually, leaving the right hand free to draw charts, diagrams, etc.) is gently and rapidly passed over the prostate to note, first of all, its size and general characteristics—enlargement, surface, induration, tenderness and adhesions, involvement of adjacent

structures. The examiner then returns to the median line of the prostate at the upper end and begins to dictate a detailed report of the condition; namely, the notch at the upper end and the furrow along the median line—whether normal, absent or deep; palpation of the tissues, whether normally elastic or indurated; areas of tenderness, etc. The length of the prostate along the median line and, possibly, the palpation of a middle lobe projecting into the bladder from above. The right lateral lobe; its size, contour, elasticity, induration, smoothness or nodularity, tenderness, adhesions, etc. Similar investigation of the left side; with possible discovery of crepitus due to small calculi. Membranous urethra; its size and character. The findings are sketched on a stamped outline like that shown in Fig. 241.

Seminal Vesicles.—These are often soft and on pressure disappear. One should remember that the vesicles meet the prostate at an angle and that the consistence is often that of a finger-cot filled with water. Examination should, therefore, be very lightly done and a delicate touch acquired in the investigation of indurations, adhesions, enlargements, and areas of tenderness in the seminal vesicles and ampullæ, and adhesions to adjacent structures.

INTERNAL EXAMINATION

Preparation of Patient.—We prefer a short table with leg holders so designed that the patient's knees are well separated and it is possible to make an examination between them. The genitalia are cleaned with a vigorous application of soap

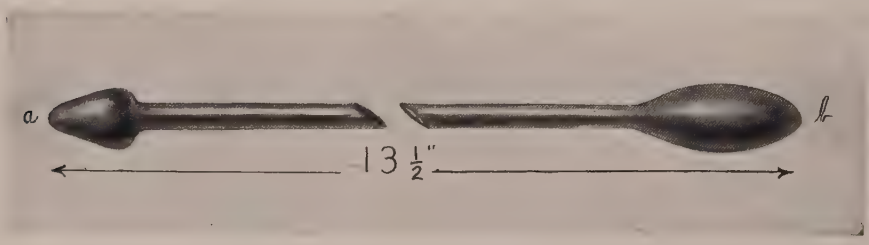


Fig. 624.—The gum-coated linen bougie à boule: *a*, Acorn tip; *b*, olive tip.

and water, and then douched with 1:1000 oxycyanid of mercury solution. The penis and particularly the region of the glans and coronal sulcus are thoroughly cleansed with an alcohol sponge. The urethra is sterilized by an injection (generally with a bulb syringe) of meroxyl (1 : 500). With the same syringe the urethra is anesthetized by injecting about 20 c.c. of 4 per cent. solution of procain. This is forced back into the bladder by injecting the urethra with an additional syringeful of procain. No difficulty is thus experienced in carrying the anesthetic into the posterior urethra and bladder. After five minutes the anesthesia is usually satisfactory. A small towel (18 inches square) with a hole about 2 inches long in the center (which has been immersed in 1 : 1000 oxycyanid of mercury) is squeezed out upon the genitalia and the glans penis drawn through the hole, the rest of the penis being covered by the towel. Before introducing instruments the glans is again swabbed with alcohol, the operator having sterilized his hands with soap and water and immersion in 80 per cent. alcohol. Rubber gloves may be used.

Exploration of the Urethra.—*Bougies à boule* (Fig. 624), varying in size, are used to detect strictures or irregularities of the urethra. It is well to start with a fairly

large size, *e. g.*, No. 26 F. Grasping the penis behind the glans between the thumb and finger it is held erect, and with the right hand one gently inserts the bougie which has been lubricated with sterile oil. As the instrument passes inward the operator is careful to note roughness, irregularities, constrictions, or complete arrest of the instrument. As the instrument is withdrawn the same notations are made. In the normal patient the end of the bougie will usually be arrested at the external sphincter or bulbomembranous juncture. By gentle, steady pressure the sphincter will usually relax and allow the instrument to pass into the prostatic urethra and perhaps into the bladder. The bougie à boule, however, is only satisfactory for the external urethra. If a larger size fails to pass, progressively smaller sizes may be used until the point of constriction is passed, and when withdrawn the length of the area of stricture is noted by observing when the instrument first reaches the strictured area and when it is released.

If bougies à boule fail to pass, one usually next employs a sound. We prefer a fairly short beak sound with a curve somewhat similar to the Van Buren model

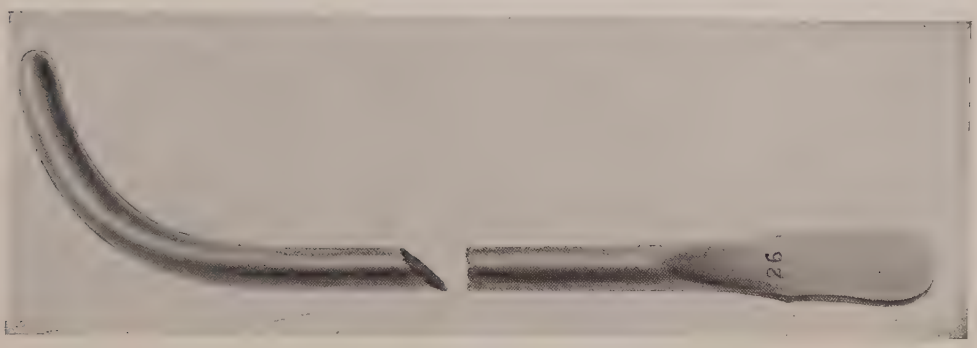


Fig. 625.—Non-rusting steel sound with moderately short beak.

(Fig. 625). While *passing a sound* the operator stands either on the left side of the patient or between the separated thighs. Selecting a sound of fair size (No. 24 F.) the instrument is held gently between the thumb and first two fingers of the right hand. The penis is held between the thumb and fingers of the left hand immediately back of the corona and carried slightly toward the left groin. Holding the sound parallel to the left groin, the beak of the instrument is introduced slowly until it reaches the penoscrotal juncture when the handle of the instrument is carried to the median line and gradually pushed further in until the beak reaches the bulbous region. Traction on the penis is no longer necessary and the operator releases his hold and places the first two fingers of the left hand upon the towel in the region of the bulb back of the scrotum. Gentle pressure here has the effect first of obliterating the pouch of the bulb and as the sound is carried onward, directing the point more certainly into the membranous urethra and through the external sphincter. When this is effected, no further aid in the perineum is necessary, but pressure on the suspensory ligament is helpful in lowering the curve of the anterior urethra and facilitating the introduction of the sound through the prostatic urethra into the bladder. If the surgeon is on the left side he usually changes hands at this point, makes pressure on the suspensory ligament at the base of the penis with the first and second fingers of the right hand, while with the left hand he gently pushes the sound through the prostatic urethra into the bladder. If standing

between the thighs it will not be necessary to change hands in this maneuver. If no obstruction is met with, progressively larger sounds up to No. 28 F., which is high normal, may be used. If a stricture impassable to one of the sounds is encountered, its position and character are noted. Before removing the larger sound the urethra should be palpated along the shaft of the sound to detect areas of induration, nodulation, granulation, inflammation, strictures, etc., and their position and character are noted on a chart or diagram. If strictures are encountered one may use (in the adult) sounds as small as No. 16 F. if care is taken not to produce traumatisms, false passages, etc.

Sounds smaller than No. 16 are dangerous and usually ought not be employed. In such cases filiforms are used. Before *passing a filiform* into the bladder one should be sure that there is sufficient fluid in the bladder to allow the filiform to curl up within it. If the patient has just voided urine the bladder may be filled

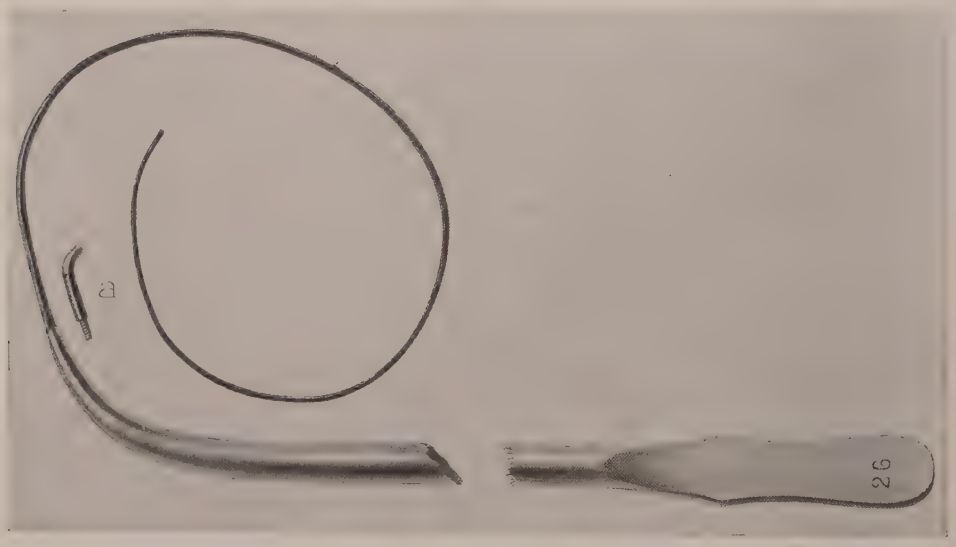


Fig. 626.—Special dilator and filiform. Owing to the fact that the filiform has a metal shank (*a*) 1 cm. in length, thus increasing the rigid length of beak, the instrument has been made shorter. A filiform with a male screw is much preferable.

with an antiseptic solution (1:4000 oxycyanid of mercury or 1:1000 meroxyl). If a tight stricture is present, it may be impossible to introduce fluid by hydraulic pressure and the operator may have to wait until the patient has drunk several glasses of water in order to fill the bladder with urine. The passage of filiforms into an empty or contracted bladder is a frequent cause of breakage of filiforms. The filiform (Fig. 626) which we use is one which can be attached to a following dilator. We have never found the whale-bone filiforms and the tunneled sounds and catheters of Gouley satisfactory, although we admit that a very delicate whale-bone filiform is occasionally the only instrument that can be passed. It is well to have on hand some very delicate thread-like filiforms for such cases, but for steady usage a more sturdy and serviceable filiform of larger caliber can be used. The dilator which we employ is one made of non-rusting steel with an especially short curve and with a screw socket in which the male screw of the filiform can be fixed. We have found the followers of Le Fort objectionable because the

curve is much too long, owing to the fact that the rigid portion of the filiform adds 1.5 cm. to the length of the instrument. The Le Fort follower is provided with a male screw which fits into the female screw in the end of the filiform. Both of these are objectionable: First, because the delicate screw end of the follower is apt to be bent or broken if the instrument falls and, second, because the cup containing the female thread is delicate, soon dilates, is apt to fit badly, and gets loose occasionally in the bladder. The instrument which we have designed and employ is seen in Fig. 626. It is made of non-rusting steel in even sizes from 10 to 30 F.

The introduction of a filiform is a delicate procedure. The urethra is extended as greatly as possible so as to eliminate pockets and folds while the filiform is gently introduced between the thumb and finger of the right hand. If obstruction is met with, the instrument will often pass if it is rotated. If the instrument will not pass, it is well to withdraw it, bend the end of the filiform slightly, somewhat

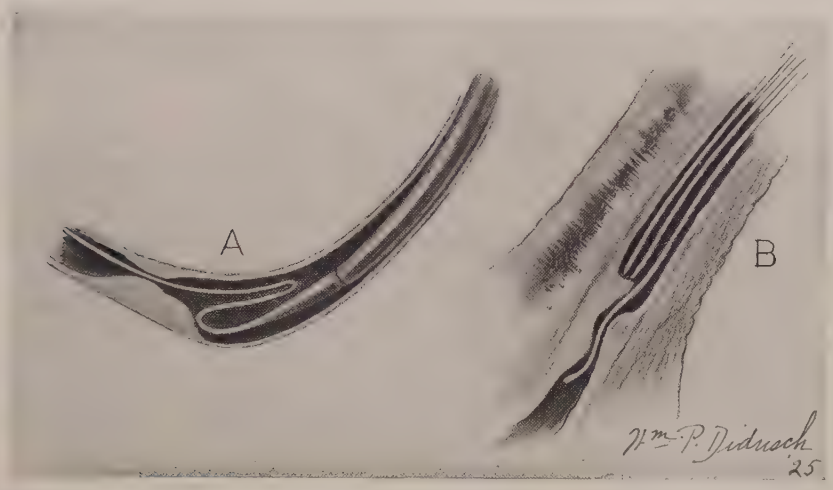


Fig. 627.—A, showing the buckling of filiform in urethra. This can usually be recognized by the feel and verified by inspection of filiform partially withdrawn; B, the use of numerous filiforms to fill pockets and facilitate passage through strictured area.

in the shape of a coudé, and then reintroduce it, attempting by rotation to find a passage. If a definite stricture is present, the urethra may be very irregular in front of it and even pouches and false passages may be present to entrap the filiform. However, by continuing the probing, using additional filiforms if necessary, changing the shape of their ends, and slowly revolving them, one will often be able to carry the filiform through even small and tortuous strictures (Fig. 627, B). When the filiform has been passed into the bladder and the outer end nears the glans, it is grasped firmly between the thumb and finger of the left hand, while the dilator is attached by a rotary motion until the screw thread is well home. The instrument is then passed into the bladder following the technic above described. Great care must be taken to see that the filiform does not become doubled (Fig. 627, A), as this may lead to a false passage. Doubling will be detected by the sudden cessation of resistance to the introduction of the filiform, and if the operator fears this has happened, on withdrawing the instrument an equally sudden release of resistance, as the filiform becomes straightened

out again, may be appreciated. The operator should withdraw the filiform at once, and inspection will show the two sharp bends, close together, which are always present if doubling has occurred. When the region of the stricture is approached care should be taken to introduce the dilator slowly and surely in the proper direction, using as much care as in introducing a sound. In the region of the bulbomembranous juncture pressure with the finger against the perineum is a valuable guide to the position of the instrument and assists materially in carrying it through the membranous urethra. Starting with followers of the lowest size others are used (without removing the filiform from the urethra) until the resistance offered by the stricture warns the operator that sufficient has been done. The filiform is then withdrawn and further instrumentation left for another séance. The treatment of strictures is described elsewhere.

If it is impossible to pass a filiform, the *urethroscope may be used to find the orifice of the stricture.* A filiform may sometimes be passed through the stricture, with the assistance of urethral forceps to direct the filiform into the orifice.

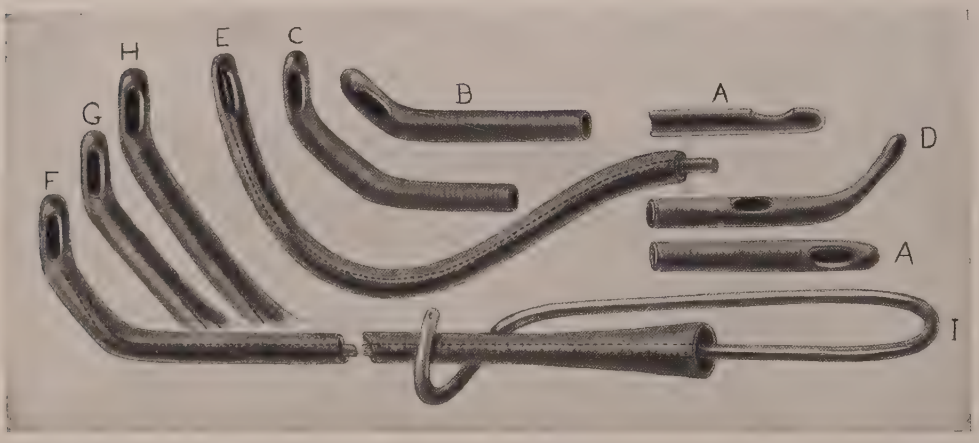


Fig. 628.—Catheters of various types: A, Nélaton rubber catheter with cavity in tip to hold stylet (I); B, Mercier coudé gum-coated or silk catheter; C, bicoudé gum catheter; D, rubber coudé catheter; E, rubber catheter with stylet with prostatic curve; F, showing use of stylet to give to coudé catheter different degrees of curvature (G, H).

Catheterization of the urethra may be done with various instruments (Fig. 628). The rubber or Nélaton catheter is the most commonly used and has the advantage of being least disagreeable and dangerous. These catheters should always contain a receptacle in the inner end of the catheter so that a stylet may be used in introducing them (Fig. 628, A, E). A simple rubber catheter without a stylet is introduced slowly until the sphincters have been overcome and the bladder reached. If a prostatic enlargement is present, a straight rubber catheter is apt to be obstructed, especially at the median lobe. It is here that the use of a stylet, which gives to the catheter a coudé curve or a large round prostatic curve is of great value (Fig. 628, E). In such cases, however, it is often simpler to use gum-coated coudé (Mercier) catheters, the shape of which is designed to ride over a median prostatic enlargement. Rubber catheters are also made with a coudé curve (D), and are very valuable. Metal catheters, preferably of silver, either with the ordinary or with the large prostatic curve, may be employed, but great care should be taken in their

use, as it is not difficult to produce false passages or severe traumatisms with these instruments.

Urethroscopy.—We shall only attempt to describe the method employed here and the instruments which we use.

The urethroscope is tubular with an external source of light, as shown in Fig. 629. The light carrier hangs free upon a peg so it may be turned from side to side by simply rotating the external plate of the urethroscope as shown in Fig. 630, A, B. This is a great advantage in that it is possible to turn the light carrier away from the end of the tube to allow the introduction of swabs and other instruments,

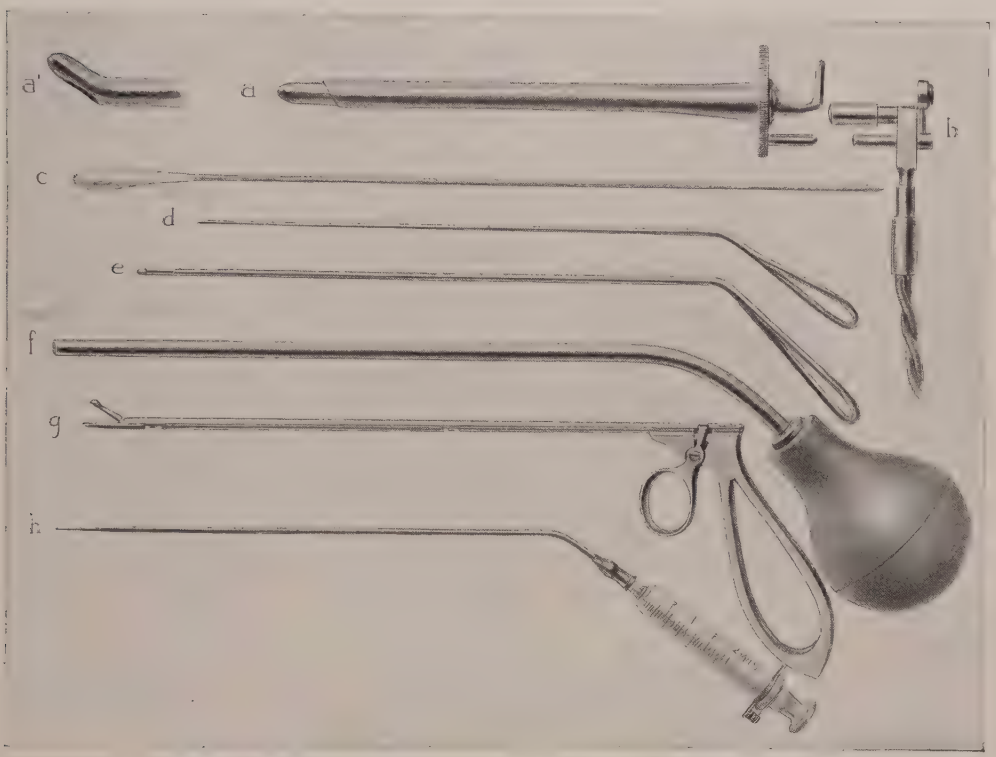


FIG. 629.—Young's urethroscope and instruments for urethroscopic operations: *a*, Straight tubular urethroscope, preferably No. 28 French. Barrel of silver. Milled plate for rotating instrument. Peg upon which light carrier (*b*) is hung, with light close to plate so as to avoid reflection. Special obturator which can be withdrawn while light carrier is in use. *a'*, Curved tube for posterior urethroscopy, if desired. *c*, Sterile cotton pledget. *d*, Conical probe for ejaculatory ducts. *e*, Applicator for nitrate of silver sticks. *f*, Evacuating bulb and tube (made specially large). *g*, Urethroscopic rongeur. *h*, Syringe and blunt needle for injecting ejaculatory ducts and utricle.

thus avoiding infection of the instruments from the unsterile light carrier. The lens is very close to the end of the urethroscope, thus preventing any reflection which would interfere with the operator's vision. The advantage of the external light over the internal light, we think, is great in that there is no lamp in the depths of the urethroscope to become soiled with blood or secretions and in that it gives a larger tube for work. The aseptic technic is also more easily made perfect.

Accessory Instruments.—Small tube and bulb aspirator, probes for ejaculatory ducts, utricle syringe (and long needle for the same), a silver-nitrate-stick carrier, urethroscopic rongeur (and when necessary a urethroscopic electrocautery and a urethroscopic fulguration wire).

With the exception of the last two instruments which are sterilized by immersion in antiseptic solution, all the instruments above described are boiled. We use an electric sterilizer which is provided with a tray which contains the instruments and which is easily held in a horizontal position upon a hook on the left leg of the table so the instruments are convenient to the operator during urethroscopy. Cotton swabs upon long wooden match sticks are kept in long glass tubes in which they are sterilized by steam.

While the instruments are boiling the patient is put on the table, legs separated upon knee crutches. The genitalia are cleaned with soap and warm water and then with 1:1000 oxycyanid of mercury. A special towel with a hole in the center is then put in place so as to cover all but the glans penis, which is swabbed with an alcohol sponge. The interior of the urethra is sterilized by means of an injection of 1:500 meroxyl, 1:4000 oxycyanid, or other non-irritating, effective

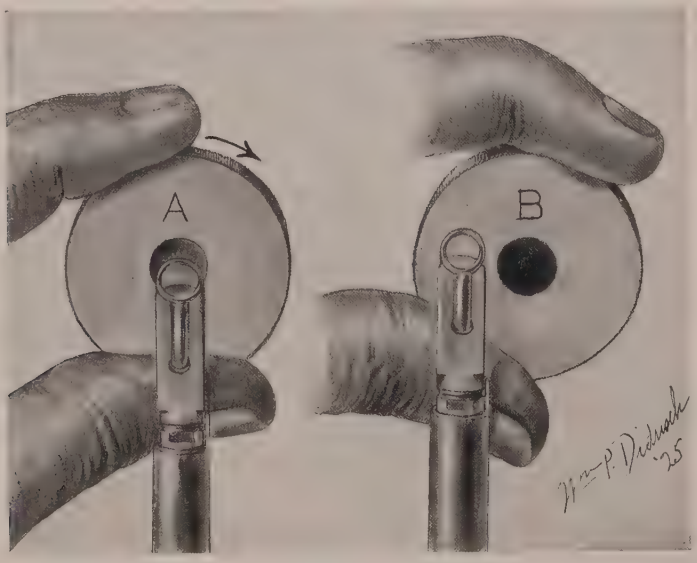


FIG. 630.—Young's urethroscope with light holder suspended on pin: A, Position for inspection of urethra through lens; B, disk rotated, throwing light carrier to one side, thus making room for passage of swabs without breaking aseptic technic.

antiseptic. Four per cent. procain is then injected by means of a bulb syringe into the urethra and forced back by a second injection of the solution or of air. In this way the bladder, posterior and anterior urethra are anesthetized at the end of about five minutes.

The instruments, which by this time are boiled, are removed in the tray which is hung upon the hook on the table leg. We usually employ a No. 28 silver urethroscope, but in some cases smaller sizes (generally No. 26) may be required. If the meatus is small, however, we perform meatotomy ventrally and introduce a No. 28 sound, after which no trouble is usually found in using the No. 28 urethroscope. Suspending the glans between the thumb and finger of the left hand, the urethroscope is pushed backward until the bulb is reached. The first two fingers of the right hand are then placed against the bulb so as to obliterate the pouch and to direct the end of the urethroscope into the membranous urethra, the outer end of the instrument at the same time being depressed so as to be in the direction of the

membranous urethra. At times spasm of the sphincter is encountered and one has to wait and use care in pushing the instrument inward. Usually no difficulty is experienced in entering the prostatic urethra. It is now important to depress the outer end of the urethroscope so that the inner end will be raised up over the verumontanum and the median portion of the prostate immediately behind it. This is effected by making pressure with the finger of the left hand against the suspensory ligament so as to greatly depress the tube in the external urethra and allow the inner end to ride over the median portion of the prostate into the bladder. Although the instrument is only 14 cm. long, the penis is compressed (telescoped) and the instrument passes several centimeters into the bladder without difficulty. When the obturator is withdrawn a gush of urine usually follows. This should be allowed to continue until the bladder is thoroughly drained. The aspirator is introduced and followed by cotton swabs to dry the field. The lamp is put in place upon its peg and inspection made. As a rule, at this point one will see the end of the tube blocked by the posterior wall of the bladder, which bulges into the lumen. As the instrument is slowly withdrawn the trigone will be reached and the herniated mucous membrane of the posterior vesical wall then disappears and urine again escapes into the tube from the trigonal portion of the bladder. This urine is evacuated and the tube slowly drawn outward until the vesical sphincter appears over the end of the tube. This is at first round, but as one comes outward the figure changes to an inverted V with the uvula vesicæ or posterior prostatic margin below and on each side the lateral sphincter muscles, which meet in a point in front and extend obliquely downward to be lost in the substance of the prostate on each side of the median portion. Plates I and IV shows the progressive pictures as the instrument is drawn outward. The vesical orifice closes triangularly. After the closed sphincter passes out of view one sees only the median portion of the prostate. Next the crista galli appears below, with a shallow pouch on each side. Continuing to withdraw the tube the verumontanum slowly appears from below until finally it rises well up and may completely fill the lumen. In normal cases it is rounded and covered with smooth pinkish mucous membrane and on its anterior surface, near the summit, is a small depression, the orifice of the utricle, and below on each side, a distance 2 to 3 mm. from the utricle and from each other, are the orifices of the ejaculatory ducts. There is great variation, however, in these orifices. The utricle may be very small or large and gaping. A probe inserted into it may pass only a few millimeters, but generally goes from 1 to 2 and sometimes 4 cm. Occasionally there is found a stricture, but generally it is quite patent. The ejaculatory ducts are generally not seen, but by probing at the proper place on each side of the median line below the utricle, they can usually be found with an ejaculatory probe-dilator which will pass from 2 to 5 cm. without much resistance. At times obstruction is met at a distance of about 2 cm. This is probably the bifurcation of the ejaculatory duct where the vas and vesicle join. By manipulating the instrument it can usually be made to pass into one of these channels 2 or 3 cm. further. Occasionally strictures or tortuosities occur which prevent introducing the probe more than a very short distance.

During this passage through the prostatic urethra a careful inspection is made for pathologic conditions, *e. g.*, polyps, cysts, areas of edema, congestion, ulceration, pouches, sinuses, etc. These are found very frequently at the prostatic

orifice on the median and lateral portions of the prostate and upon the verumontanum, which is often enlarged, congested, granular, edematous, and occasionally with polyps springing from its surface. Coming still further outward the anterior part of the prostatic urethra is seen and is rarely found abnormal. The membranous urethra appears as a central pinpoint figure with radial striations or folds of mucous membrane. This condition persists for about 2 cm., at which point the bulbous urethra is abruptly encountered when the end of the instrument comes out of the external sphincter. The urethra here is dilated and appears generally as a vertical slit, the mucous membrane being pale. Fluid is usually encountered here and requires evacuation and swabbing. Along the floor of the bulbous urethra one may search for the orifices of Cowper's glands at a point from 1 to 3 cm. in front of the external sphincter along the floor of the urethra. One occasionally sees inflamed ducts of the peribulbar glands, but, as a rule, all these are invisible. Reaching the anterior part of the bulbous urethra the orifice becomes again pinpoint in

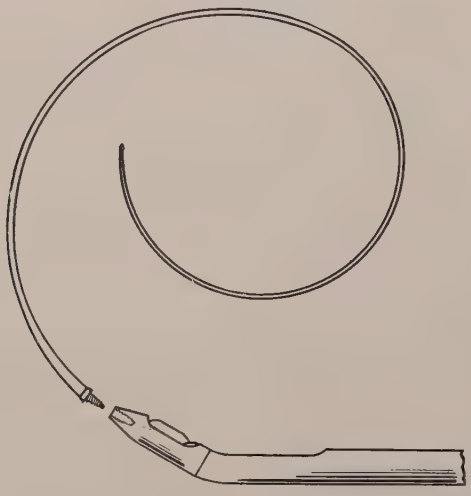


Fig. 631.—Frontz cystoscopic lamp-cap provided with filiform to facilitate introduction of cystoscope in difficult cases.

character with radial striations of pink mucous membrane. As the tube is slowly drawn outward the orifices of Littré's glands are often visible and occasionally the larger lacunæ, but both of these may be practically invisible unless inflamed. Other abnormalities, such as areas of ulceration, granulation, stricture formation (as shown by irregularities of contour and failure of the central figure to close over the end of the urethroscope) are sometimes seen. When the fossa navicularis is reached the urethra again becomes patent and irregular, often a vertical slit, sometimes T shaped. The mucous membrane is pale and occasionally the orifice of larger glands and lacunæ are seen.

During this passage of the urethroscope pathologic lesions are, of course, subjected to appropriate treatment. Strictures of the ejaculatory ducts are dilated by passage of the probe-dilator. Applications of nitrate of silver are made to ulcerations, granulations, areas of edema, congestion. Polyps are seized with the urethroscopic rongeur and removed and their bases touched with nitrate of silver or with the electrocautery. The inflamed ducts may be injected with 1 per cent.

silver nitrate by means of the urethral syringe and needle. Fulguration may be done if desired.

The above described maneuvers may also be carried out through telescopic instruments filled with air or water, such as those of McCarthy and Buerger, in a perfectly satisfactory way.

Cystoscopy.—Since the epoch-making invention of Nitze, the cystoscope has undergone various modifications, but the principles remain practically unchanged. We shall not attempt to describe the instruments and methods used elsewhere, but shall simply give those which we use.

While the simple indirect cystoscope of Nitze still gives just as beautiful pictures as any instrument which has since been introduced, we have come to the employment of an American-made evacuating cystoscope of Wappler by means of which the ordinary inspection of the bladder may be done, also ureter catheterization and intravesical operative work, by simply changing telescopes and without removing the outer sheath of the instrument. This instrument carries an observation telescope giving either a corrected or an uncorrected picture,

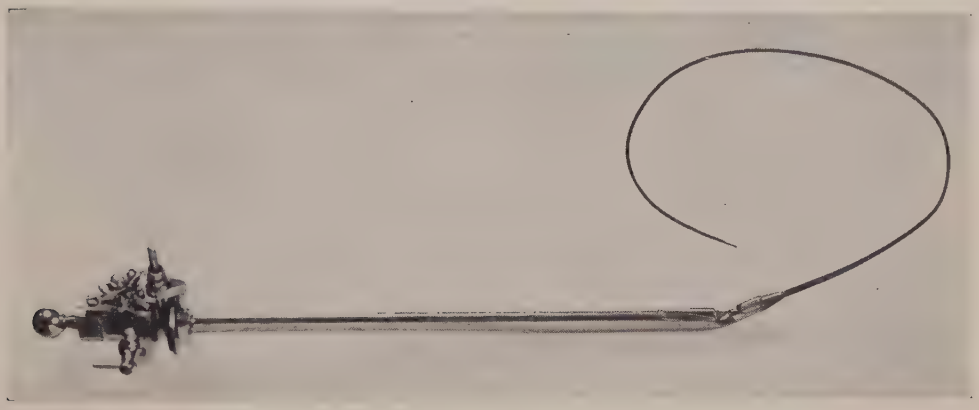


Fig. 632.—Cystoscope provided with filiform for introduction in difficult cases. Frontz.

depending on the lens system employed. The instrument is introduced with an obturator. The beak which joins the shaft so as to produce a coudé curve is generally one of the most satisfactory of all urethral instruments to pass. It is usually advisable to use the finger in the perineum to cause the cystoscope to enter the membranous urethra easily and then to depress the suspensory ligament to facilitate passage over the median portion of the prostate into the bladder. Occasionally obstructions are met with in the prostatic urethra which require skilful manipulation, change of position, elevation or depression, and rotation to various angles of the beak of the cystoscope. Rarely it is necessary to introduce the finger into the rectum to obliterate a pouch or raise the cystoscope over an obstructing bar or lobe. Sometimes the beak catches on the anterior wall and special procedures may be necessary to pass it into the bladder. Frontz has made use of a filiform screwed into the lamp-carrying beak for otherwise impassable cases (Figs. 631, 632). Once the cystoscope is in the bladder the obturator is withdrawn, the *residual urine obtained* and carefully measured. (The patient should always be instructed to void immediately before mounting the table so that the urine found in the bladder will be the true "residual.") The bladder is then filled by attaching to one of

the stop-cocks a tube from an irrigating apparatus, preferably containing an antiseptic solution (1 : 4000 oxycyanid of mercury or meroxyl). Closing the end of the instrument with pressure of the thumb and opening the stop-cock the fluid is allowed to fill the bladder until the patient complains. The inflow is then stopped and the outflowing fluid caught in a graduated glass to *determine the capacity of the bladder*. The bladder is then filled until about 200 c.c. fluid has been introduced, unless it is necessary to wash it out several times to obtain within the bladder a clear field. When hemorrhage is present it may be necessary to make the study with a cloudy field and several evacuations and refillings may be necessary to complete the study. In some cases it is wise to have the fluid continue to flow into the bladder while the examination proceeds. This is particularly true when blood is passing by the side of the cystoscope through the prostatic orifice into the bladder. Having obtained a fairly clear field, the operator first takes a cursory series of views in different parts of the bladder to note any pronounced abnormalities. If an inter-

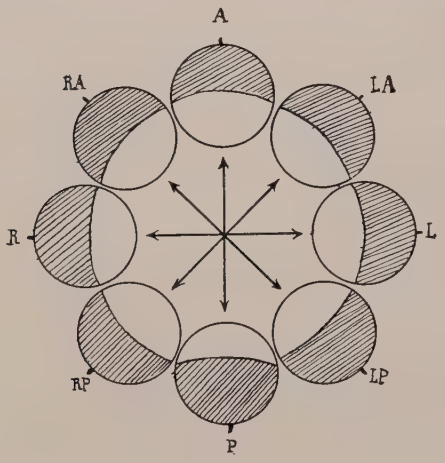


Fig. 633.—Prostatic orifice as seen with cystoscope, corrected view. Arrows show the direction in which each portion of the prostatic margin is viewed: *A*, Anterior; *R*, right; *P*, posterior; *RA*, right anterior; *RP*, right posterior, etc.

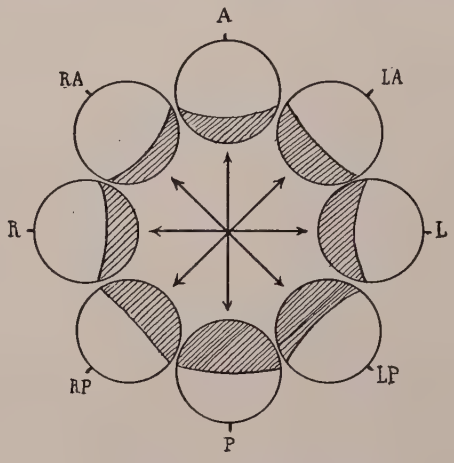


Fig. 634.—Prostatic orifice as seen with cystoscope, with uncorrected view lens system.

esting pathologic condition is discovered and, particularly, if the case is difficult owing to bleeding or increasing cloudiness of the fluid, it may be well to study immediately, as completely as possible, the tumor or other pathologic condition discovered. In other cases the operator should set about to make a systematic survey of the bladder.

When using an ordinary instrument with a line of vision at right angles to the shaft of the cystoscope it is, of course, necessary to take views in many different positions. The angle of the cystoscopic lens varies generally from 60 to 90 degrees and to see the entire bladder it is, therefore, necessary to rotate the instrument progressively from 60 to 90 degrees and back or forth in each position in order to study systematically the 360 degrees comprised in the entire bladder interior. The procedure which we usually employ is as follows:

The cystoscope is introduced, rapidly rotated, and drawn back and forth through the bladder to look for any interesting pictures. We usually turn to the trigone and region of the ureters to note the condition. The *prostatic orifice* is next studied

and if abnormal, record is made upon a "cystoscopic chart." As seen here the successive views of the prostatic margin, anterior, right anterior, right, right posterior, posterior, left posterior, left, and anterior are recorded. The picture in a normal case with a corrected optical system is shown in Fig. 633. With the uncorrected cystoscope the views obtained are shown in Fig. 634. Elsewhere are described the changes which occur with prostatic bars, lobes, valves, and pathologic conditions at the prostatic orifice. We have there also described the "motion pictures" of the prostate which we make to demonstrate the change in picture produced by the change in position of the inner end of the cystoscope and its relation to the prostatic margin, adjacent bladder wall, ureter, etc.

In order to study the bladder completely the instrument is then turned upward so as to view the anterior wall and the beak pushed backward as far as possible and then drawn slowly forward until the prostatic orifice is seen. There is often a pouch just above the anterior margin of the prostate and it will be necessary to depress the handle of the cystoscope externally in order to elevate the inner end sufficiently to see the anterior wall immediately adjacent to the prostatic margin. Rotating the instrument about 60 degrees the right anterolateral wall of the bladder is studied as the instrument is slowly pushed backward. Rotating another 60 degrees the instrument is drawn out while the operator studies the right posterolateral wall. The next rotation of 60 degrees makes it possible to study the base of the bladder or posterior view. As the instrument passes backward one notes the median portion of the prostate, the trigone, the ligamentum interuretericum, the depression immediately back of it, and the posterior wall of the bladder. In order to see as far up as possible the handle of the cystoscope should be greatly depressed as successive views of the posterior wall of the bladder are obtained. In this way it may be possible to see as far back as the vertex of the bladder. The left lateral wall is successively studied until the anterior wall is again reached. By elevating the handle of the cystoscope, while looking forward, the vertex of the bladder may again be seen. By making pressure on the suprapubic region portions of the anterior wall and vertex may be brought closer to the cystoscope.

Normal Views.—The trigone is easily recognized, since it is slightly elevated above the surrounding bladder wall and by the presence of more numerous vessels in the mucous membrane which increase as one approaches the prostatic orifice. The ligamentum interuretericum which forms the posterior limit of the trigone is generally elevated above the retrotrigonal depression. The ureteral ridges continue the trigone upward and outward on each side containing the slit-like or oval ureteral orifices and finally disappear into the vesical wall. The pictures in Plates I and XV show the views obtained in normal cases. The bladder is usually paler than the trigone. The vesical veins and arteries are visible as they enter the submucosa and spread out in stellate form or irregularly beneath the vesical mucosa. Between the vessels the mucous membrane is usually pale. The muscle bundles may not be visible, but if the bladder is greatly distended, slight depressions between them may be seen and when the bladder is in spasm or violent contraction (efforts to urinate, etc.) the bundles may become very prominent with deep pouches between. During cystoscopy the picture may be immediately changed by a strong desire to urinate or vesical spasm. With the instrument looking posteriorly one sees the trigone quickly contract, become shorter in every direction, the margins elevated and the ureteral ridges very prominent, while depressions appear behind

and on each side. The wave of contraction continues down into the urethra and violently pulls the median portion of the prostate backward, thus widely opening the prostatic orifice. If a small median lobe is present, this violent contraction of the trigone may cause the lobe to disappear almost completely into the tissues. When the spasm disappears the trigone relaxes, the median portion of the prostate rises and again closely presses against the shaft of the instrument, the ureters separate and their ridges relax and disappear into the vesical wall. During such contraction the vessels of the bladder and especially of the trigone become greatly congested and perhaps markedly dilated. If the contraction continues violently for some time, small terminal ecchymoses, which have the appearance of telangiectases, may be found with the cystoscope in the vesical mucosa. The same picture may be obtained occasionally when the bladder has been greatly overdistended and suddenly evacuated. Vessels which have been completely emptied by the overdistention sometimes rupture as a result of the sudden release of pressure. The anterior wall is, as a rule, paler and takes less part in the spasmodic contraction during urination. In studying the trigone one notes the presence or absence of hyperemia, congestion, edema, inflammation, ulceration, cysts, polyps, hypertrophy, and other abnormalities. Ureteral orifices which appear as slits or oval openings in slightly elevated ridges in normal cases, may exhibit manifold pictures, such as irregularities of location, size, shape, and elevation. The movement of the ureteral orifices associated with the intermittent ejection of urine from the ureter should be noted and the character, frequency, and appearance of the urinary stream described. Where the ureter or kidney is completely blocked by stones, or kidney atrophy of long standing is present no movement may be seen at the ureteral orifice nor any contraction of that corner of the trigone, a finding of diagnostic importance.

In tuberculosis, or other disease in which the ureter is greatly shortened, the ureteral ridges may be drawn outward and in some cases, as described elsewhere, there may be a piston-like to-and-fro play of the ureteral ridge through the orifice synchronous with respiration. This is due apparently to adhesions between the kidney and diaphragm which causes the ureteral orifice to be pulled upward with expiration. One should be on the outlook for abnormally situated ureteral orifices or multiplicity of openings, and as stated elsewhere when the ureter cannot be found in its normal position it should be sought for in other places along the base of the bladder, trigone, and urethra. Special attention should be directed to pathologic conditions, abnormalities, foreign bodies, etc., which may be detected. The rest of the examination should be sufficiently complete to demonstrate that no other abnormalities exist. If vesical tumors are discovered, an effort should be made to study carefully various portions of the tumor in order to determine the appearance and character of the neoplasm, the size and character of its attachment to the bladder, the presence of infiltration, and the condition of the adjacent vesical wall. Careful inspection of other portions of the bladder must be made to determine whether other tumors are present and the relation of the tumor to prostate, urethra, ureteral ridges, trigone, etc., should be carefully mapped out. The size of a tumor or stone in the bladder can be quite accurately determined by the following procedure: With the instrument so turned as to view the tumor, it is pushed slowly inward until the edge of the tumor appears in the center of the field. An assistant then notes with a pencil point or finger near the handle of the cysto-

scope its position while the operator slowly withdraws the instrument in a straight line (without elevating or lowering or turning the shaft), and as soon as the opposite side of the tumor appears in the middle of the field of vision, the assistant notes the distance through which the handle has moved. This should give accurately the diameter of the tumor or stone in this given direction. We frequently employ this method and find it very valuable in determining the exact size of objects seen through the cystoscope (Fig. 635).

In case of calculi it is important to note whether the stone is movable or fixed. This may be determined either by pushing the stone bodily with the cystoscope or by rotating the patient's pelvis and causing the stone to roll down to a new lower level. When the stone refuses to move it may be attached to an encysted calculus. If diverticula are seen they should be investigated as thoroughly as possible, the size, character of the lumen, and its relation to the ureters, trigone, vertex of the

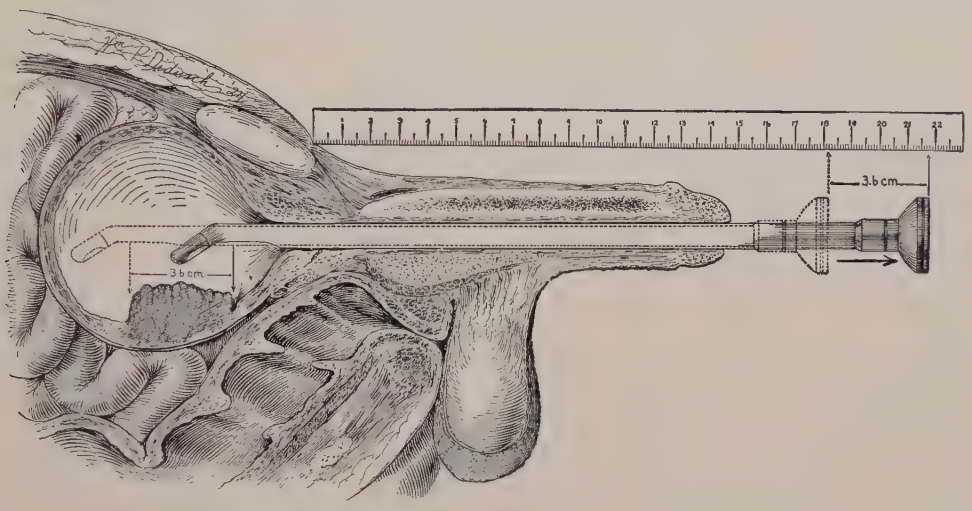


FIG. 635.—Diagram showing the manner in which the size of a tumor, stone, or other object in the bladder may be measured by means of the cystoscope. The rule should be firmly pressed against the symphysis so that it will not move. After observing one edge of the object exactly in the middle of the cystoscopic field, the cystoscope is pushed in until the opposite edge lies in the middle of the cystoscopic field. The distance which it is necessary to push the cystoscope in order to do this represents the width of the object in a direction parallel with the axis of the urethra. The width from side to side can be estimated by comparing it with the anteroposterior diameter already determined.

bladder, or other important regions should be noted. If possible, the cystoscope should be introduced within the diverticulum and a study of its interior made. Sometimes calculi are thus discovered. Not infrequently the ureteral orifice may be drawn into a diverticulum and found there by intradiverticular cystoscopy. Diverticula are often multiple and associated with numerous cellules, in which case their location, character, and probable depth should be noted as carefully as possible in order that the necessity of an operation may be determined. Careful study of the mucous membrane for the lesions produced by submucous cystitis (small red lines or areas which bleed as the bladder is distended with fluid), ulcerations—simple or tuberculous—and other inflammatory conditions of the bladder wall should be carefully noted and described.

We have not space here to do more than thus briefly indicate the manifold possibilities of the simple cystoscope. Suffice it to say that the examination should be

systematic and thorough and that besides describing important regions as normal any marked abnormality should be described in detail, preferably illustrated by drawings, figures, or charts, or upon a stamped anatomic outline.

Ureter Catheterization.—After a careful history of the patient has been taken, and the preliminary examination of the genitalia, prostate, seminal vesicles, and urine has been made, one can usually determine before cystoscopy is done whether ureter catheterization should be carried out. It is often desirable to have a plain *x*-ray made so as to be forewarned of pathologic conditions in the urinary tract; enlargement or abnormal position of kidneys, calculi, etc. If there is a possibility of wanting to carry out ureter catheterization, preparation should be made so that this can be done without delay after simple cystoscopy.

Catheter Sterilization.—Catheters should be thoroughly cleansed in soap and warm water which should also be injected through the catheter with a syringe. They should be wiped with alcohol which should also be injected into the interior of the catheters, and then they should be placed in a tray containing 1:1000 oxycyanid of mercury which is likewise injected through the catheter. Careful bacteriologic studies in our laboratory show that the exterior and interior of catheters are sterile within five minutes after immersion in 1 : 1000 oxycyanid of mercury. This emphasizes the necessity of washing away all oxycyanid before taking specimens for culture through a ureteral catheter.

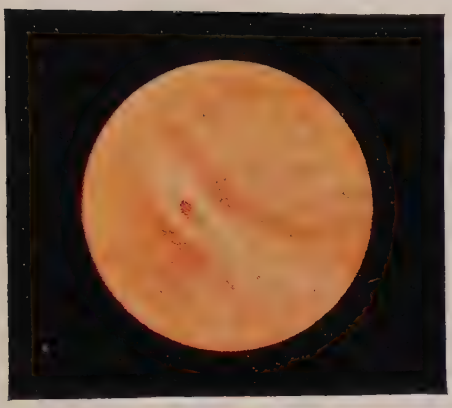
Choice of Catheters.—Ureteral catheters should be of the best quality and in good condition without cracks or fractures and the inner end should contain an opening which will surely drain the ureter above satisfactorily. For this purpose the "flute-end" or "whistle-tip" catheter is the best in our opinion. In some cases these will not pass readily either into the orifice or up the ureter and one should, therefore, also have catheters with a conical tip. It is well to use the largest catheters that the cystoscope can easily carry. We generally try to introduce two No. 7 catheters, although a No. 6 or sometimes even smaller ones may have to be used, owing to inability to introduce a larger catheter. The catheters made with fairly rigid walls and impregnated with bismuth or other material which will show a shadow in an *x*-ray should be chosen.

At times the catheter is not rigid enough in the presence of folds or definite obstructions in the ureter and it is, therefore, wise to have on hand stylets of fine bronze wire, previously sterilized by autoclave in a long glass tube the two ends of which are stoppered with cotton. It is also well to have on hand a large catheter of the conical type devised by Garceau, which is used, in cases in which the catheter will pass only a short distance, to block completely the ureteral orifice and thus avoid the escape of urine into the bladder.

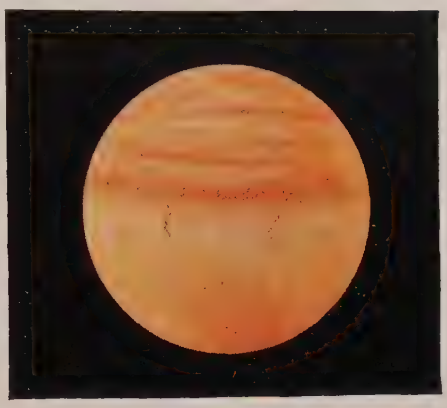
The catheterizing telescope which has been cleansed and immersed in 1 : 1000 oxycyanid of mercury is then provided with the two catheters which are to be used. We make it a rule to use a catheter with the outer end cut obliquely on the right side. The patient is covered with a special sterile ureter catheterization sheet which covers the lower abdomen, genitalia, and each thigh. The genitalia and urethra having been cleaned up as usual and injected with 4 per cent. procain, the sterile sheet is brought up around the penis, the cystoscope introduced, and the obturator withdrawn. The residual urine and bladder capacity and vesical tonicity are noted and specimens of urine obtained for cultures. As soon as the escaping fluid is clear the observation telescope is introduced and a careful study of

PLATE XIX

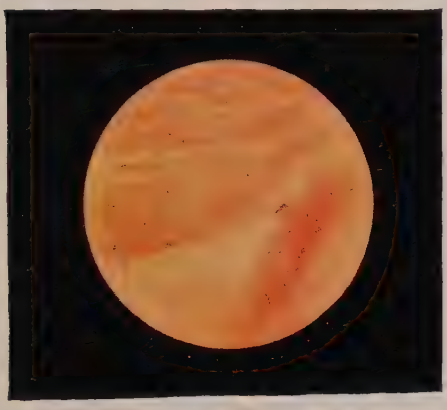
URETERAL ORIFICE IN HEALTH AND DISEASE



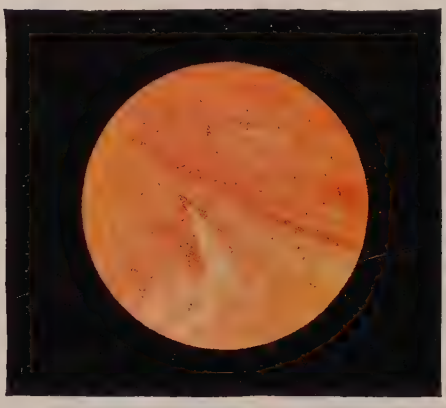
A. Normal trigone, ureteral ridge, ureteral orifice and bladder.



B. Normal trigone and posterior wall of bladder.

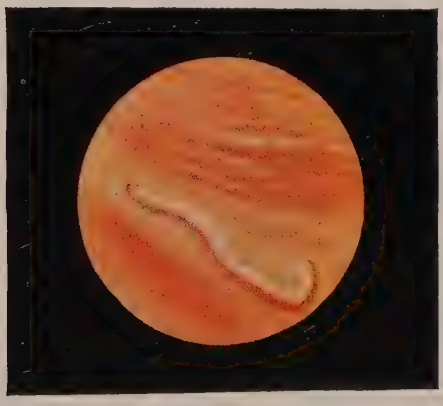


C. Jet of clear urine emerging from left ureter.



D. Purulent urine emerging from right ureter.

E. Hematuria from left kidney.



F. Worm-like stream of pus from the right ureter.

the bladder made, as previously described. Having determined that the ureters should be catheterized, a very accurate study of the ureteral orifices and their relation to other structures—trigone, ureteral ridges, prostatic orifice—is made. By *ureteral meatoscopy* much can be determined as to the probable character of lesions above; for example, in pyelonephritis the margins of the orifices are apt to be red and often edematous and swollen. If chronic ureteritis is present, the orifice may be wide open or golf-hole in character. In tuberculosis the orifice and the region around it may show evidences of tuberculosis in various stgaes, hyperemia, edema, nodulation, swelling, ulceration, etc. If the ureter is greatly shortened by the tuberculous process, the orifice may be drawn outward and if the tuberculous kidney is attached to the diaphragm the hypertrophied ureteral ridge may play back and forth through the ureteral orifice like a piston-rod. If a stone is in the ureter, the orifice may be violently drawn upward with the outflow of urine or the urine may be tinged with blood. If the stone is near the ureteral orifice, inflammatory changes may be present, and if the stone is incarcerated within the intramural portion, a rounded elevation may be visible above the ureteral orifice. In intravesical incarcerations of ureteral calculi, the stone may project into the bladder like a rounded tumor covered with mucous membrane, in the summit of which is the ureteral orifice. A similar picture may be present when intravesical ballooning of a ureter (ureterocele) is present, but in such cases the swelling collapses between the jets of urine. Strictures of the ureteral orifice may be recognized by the size and character of the orifice and the fine stream of urine ejected. Tumors of the kidney are frequently disclosed by a jet of bloody urine from the orifice, but this is also seen in tuberculosis, stone, essential hematuria, and other conditions.

The stream of urine which escapes from each ureter should be carefully observed as to the size of the stream, the character of urine, the interval between jets, etc. Not infrequently where it is impossible to pass a catheter up the ureter, such preliminary notations on the ureteral orifice and of the urinary stream are of great assistance in diagnosis and treatment. The ureteral orifice must be carefully studied with a plain cystoscope with the idea of determining beforehand difficulties that may be encountered in attempting ureter catheterization. In this regard it is well to observe carefully the character of the ureteral ridge and the trigone for elevation, inflammation, and other pathologic conditions. Where the trigone projects considerably into the bladder, or is greatly hypertrophied or septum-like, the ureters may join the bladder at an abrupt angle and catheterization be impossible. Diverticula are prone to begin just external to the ureteral orifices and thus displace and deflect the ureter in their growth. Their presence may make ureter catheterization difficult or impossible, especially if the ureteral orifice has been drawn into the diverticular cavity.

If the median portion of the prostate is markedly elevated either by a bar or a lobe, ureter catheterization may be very difficult and often impossible. In such cases it is necessary to elevate greatly the handle of the cystoscope in order to see the ureter behind the prostatic elevation. This should be noted before attempting ureter catheterization. The stream of urine which emerges from the ureter, as remarked above, should be carefully observed. It is generally possible to determine when the urine is markedly purulent. Not infrequently one sees a thick worm-like stream of pus emerge in cases of pyonephrosis or tuberculosis. Blood is usu-

ally visible unless slight and it is important to note this or its absence because one frequently gets blood in the urine through a ureter catheter as a result of traumatism from the catheter. In tumors of the ureter one occasionally sees a process of the neoplasm projecting from the orifice into the bladder. In one of our cases it traveled back and forth intermittently.

Having determined as carefully as possible the character of the ureteral orifice and noted any changes in the structures adjacent, and the character of the urine or secretion evacuated, one is prepared to proceed with *ureter catheterization*. Having washed the bladder clean, the examining telescope is removed. The catheterizing telescope, with the ureter catheters (the ends of which are plugged with round toothpicks) in place, is quickly inserted and the cystoscope turned first in the direction of the suspected ureter. As soon as the orifice is recognized the catheter is

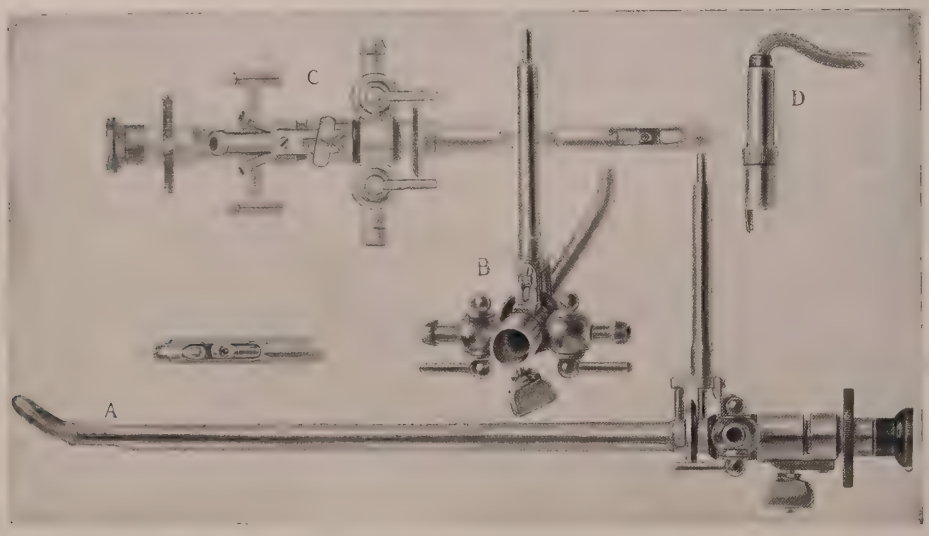


Fig. 636.—Young's observation and catheterizing posterior cystoscope with rotating irrigation apparatus: A, Side view showing extra long handle to which cord is attached. This prevents infecting the hand from unsterile cord connection D. This handle is attached to the irrigating piece and revolves with it around the shaft of the instrument, as shown in B. A large gutta-percha disk is provided about 2 cm. from the end of the cystoscope and outer edge is milled so that it may be used in rotating the cystoscope and thus take the fingers away from the eyepiece. In C the undersurface is shown and the large size of the irrigating nozzles is apparent. With this instrument quick evacuation is possible and the twisting of the rubber tube when the instrument is rotated is avoided by the fact that the cystoscope revolves within the irrigating mechanism.

pushed inward until it appears in the field of vision, when it is promptly elevated by turning the external elevating bar until the end of the catheter is fairly close to the ureteral orifice and in the direction of the ureteral ridge. To enter the ureter with the catheter it is generally best to push the entire instrument forward and outward until the catheter enters the orifice. It may be necessary to change the angle of deflection or to push the catheter back and forth through the cystoscope, but, as a rule, little difficulty is experienced in entering the ureter and in rapidly pushing the catheter upward until the pelvis is reached. It may be necessary to change the position of the cystoscope both longitudinally and by rotation and to manipulate the elevator and the catheter itself, in various ways, to facilitate the introduction and upward passage of the catheter. Such maneuvers and "tricks" can only be learned by practice.

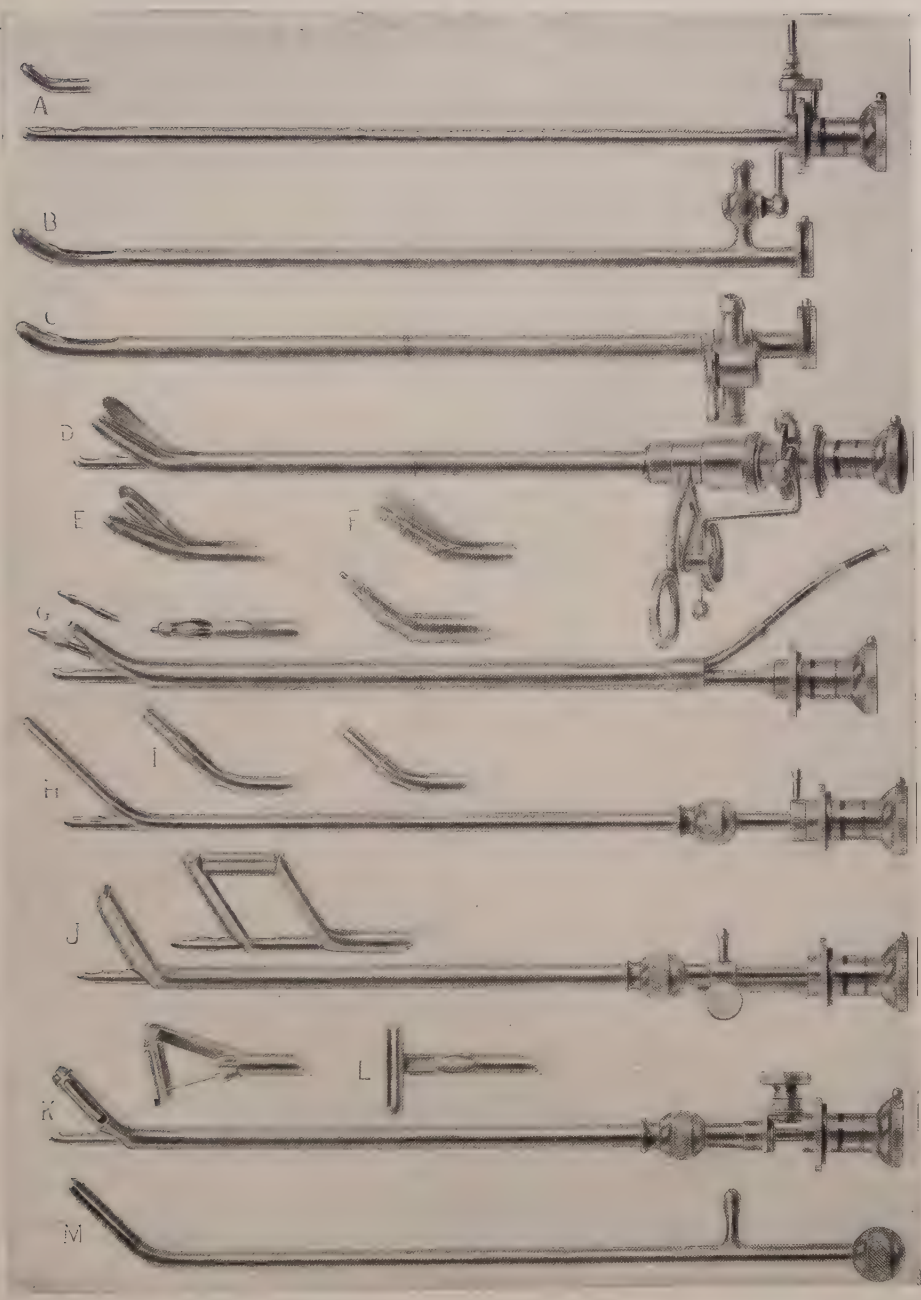


FIG. 637.—Young's straight cystoscope and the instruments which have been designed to use with it: A, Lamp with curved beak for cystoscopy in children (No. 15 F.). B, Small irrigating sheath with rotating valve at extreme outer end. C, Large evacuating tube for cases of severe hemorrhage with three-way irrigation valve. D, Cystoscopic rongeur with focusing device. E, Rongeur provided with electrocautery within the blades. F, Solid blades for heavy duty (calculi). G, Special sheath for carrying wax-tip bougies (concealed in beak during introduction). H, Radium instrument No. 1 carrying two 100-mg. tubes radium tandem. I, Same, carrying two tubes side by side, long and short beaks shown. J, Parallelogram radium cystoscopic applicator. K, Triangular cystoscopic radium applicator. L, T-shaped cystoscopic radium applicator. M, Radium applicator without cystoscope for rectal and urethral work, beak covered with gutta-percha over silver and carrying two 100-mg. tubes of radium tandem.

Having catheterized one side successfully, the operator turns his attention to the other ureter unless only one side is to be studied. The technic of catheterizing the second ureter is identical with the first, and when this catheter has also passed well up into the ureter or as far as it will go, the cystoscope is to be removed so that the catheters may remain alone in the urethra. The great advantage of the evacuating or sheath-cystoscope, with its removable telescope, is that little difficulty is experienced in removing the cystoscope and leaving the catheters behind. Our great objection to the catheterizing cystoscopes used abroad is that they are not evacuating instruments and the telescope is not removable. As a result, the entire cystoscope has generally to be left in the urethra while the collection of specimens, the preparation of pyelograms, functional studies of the kidney, etc., are made. As more than one-half hour is usually consumed in these procedures, the great advantage in removing the cystoscope is seen at once. To remove the cystoscope one first pushes the catheters inward by means of the toothpicks until the ends of the catheters are within the cystoscopic channels. The toothpicks are then removed, the catheterizing telescope pulled slowly outward until the catheters can be grasped outside the cystoscopic sheath. The ends of the catheters are then pulled out of the external cystoscopic canals and held firmly by the finger against the cystoscopic sheath while the catheterizing telescope is withdrawn, leaving the catheters free within the cystoscopic sheath. Before attempting to remove the catheterizing telescope the operator must be sure that the elevator is depressed, else it will be impossible to remove the telescope. With the ureter catheters free in the sheath the operator pushes the catheters inward until their ends are even with the end of the cystoscopic sheath, which is then withdrawn. In almost all cases the catheters will not be pulled downward to any appreciable extent by the manipulations above described in withdrawing the cystoscope.

Having employed a ureter catheter with an obliquely cut end for the right ureter and a square cut end for the left ureter, no difficulty is experienced in differentiating the two catheters which now project from the urethra. The terminal portion (3 inches or more) of each catheter should be wiped with an alcohol sponge to resterilize it. It is well to allow a few drops of urine to escape in order to wash each ureter catheter free of the antiseptic fluid which it first contained. After this a sterile test-tube is placed beneath each catheter, the sterile cotton plug inserted, thus holding the catheter in place. Collection is then begun on each side and the rate of flow and character of fluid which emerges carefully noted from time to time. Not infrequently after a short interval in which the urine on one or both sides has been clear, blood will appear. On this account, when a small amount of fluid, sufficient for microscopic study, has been obtained on either side, this tube should be removed and replaced by another. If one waits too long in the collection, not infrequently the fluid will become stained with blood from traumatism within the ureter due to the catheter. In cases where hematuria is present before examination on one side, it is very important to prevent this occurrence if possible, especially on the opposite side.

Study of Urine.—As remarked above, the first urine is allowed to escape, as it is mixed with antiseptic solution contained by the stoppered catheters, but after a few drops have escaped (sufficient to wash the catheters free from the solution) the urine is caught in a sterile test-tube for cultures. An early specimen is preserved for careful microscopic study and the second specimen obtained should be sufficient in amount to carry out a urea test.

In most cases it is desirable to have comparative phthalein tests of the two sides. One c.c. of a 0.6 per cent. solution is injected intravenously and the appearance time on each side obtained. After that a collection for fifteen minutes is carried out. This time usually suffices but in very important cases, or cases where the elimination is very slow, a thirty-minute estimation may be preferable.

In some cases where the patient is intolerant to the catheter, his condition weak, or other reason present for hurrying the examination, the operator may have to forego taking a phthalein test and be content with an estimation of urea from the two sides. Although this does not give as accurate data as separated phthaleins, it is of distinct value in showing the character of the urines excreted by the two sides.

Centrifugalizing the urine in a high power centrifuge, careful microscopic examination of the sediment should be made for cells, casts, crystals, and bacteria. If tuberculosis is suspected, a very prolonged search of numerous specimens may be necessary. On this account an abundant collection of fluid from the suspected side should be on hand, and if tubercle bacilli are not found, a guinea-pig should be inoculated.

In cases of hematuria, as remarked before, it is very important to have no traumatism of the ureter on the supposedly sound side so as to avoid instrumental bleeding. Where the hematuria is small in amount, traumatic bleeding may confuse the picture greatly, but it is rarely pronounced or sufficient to confuse the picture when the hematuria from one side is very marked.

Pyelography.—The next procedure of importance while the ureter catheters are still in place is a pyelogram. There should be definite indications for this, as the procedure is not innocuous and is occasionally followed by considerable reaction and much pain. The information afforded by this procedure, however, is so valuable in many instances, such as renal tumor, tuberculosis, stone, hydronephrosis, polycystic kidney, pyelonephritis, stricture of the ureter, etc., that it should be done in the majority of cases. If the urinalysis or previous *x*-rays or the symptomatology show that bilateral disease is present, it may be highly desirable to carry out bilateral pyelography. This is undoubtedly a much more serious procedure than the unilateral pyelogram, due to the fact that severe reactions—renal colic, and even partial or complete suppression of urine and anuria—may occur following a pyelogram.

In the early days of pyelography with collargol, the reactions were not infrequently severe and occasionally fatal. With argyrol the reactions were less severe. but not until thorium nitrate was introduced to the profession by Burns,[1] as a result of studies in this clinic, did pyelography become practically safe and a harmless procedure. Subsequent work of Cameron, with potassium and sodium iodid, and of Weld,[2] with sodium bromid, have added two other harmless and satisfactory shadowgraphic media for pyelography.

Experience has shown that harm is done by injecting the medium forcibly through the catheter into the renal pelvis with a syringe. With the use of a burette and hydrostatic pressure alone to fill the renal pelvis we have never had a serious accident with thorium nitrate in 15 per cent. solution. The fact that the drug is

[1] Journal of the American Medical Association, 1915, lxiv, 2126, 2127; Johns Hopkins Hospital Bulletin, 1916, xxvii, 157–164; Journal of Urology, 1918, ii, 145–151.

[2] Journal of Urology, 1919, iii, 415–426.

non-toxic and non-irritating has been shown in hundreds of cases. Introduction of the solution should cease as soon as the patient complains of even slight pain in the renal pelvis, as reactions may be produced by a simple salt solution under pressure. Even though great care is used, the traumatism produced by catheterization and injection of fluid is sufficient to bring about ureteropelvic spasm, very severe pain and even nausea, vomiting, and occasionally severe reactions, in apparently simple cases with little or no renal disease present. On this account bilateral pyelography is only done when there are very definite reasons for carrying it out. We do not take the position that pyelography should never be done on both sides at the same séance. There are many cases in which it is so important to know

Fig. 638.—Young's combined cystoscopic and *x*-ray urologic table. Position for cystoscopy. Note adjustable bars with knee supports, wheel operating worm gear to change position of table top, our flat Bucky diaphragm beneath flat top of bakelite, *x*-ray tube in position for skiagraphs.

what a pyelogram would show on the opposite side that we carry it out, although with some hesitation and great care.

The *position of the patient for pyelography* is very important. The urologist who has to catheterize his patient in the radiologist's office and upon the ordinary *x*-ray table is at a great disadvantage, not only on account of the difficulties resulting from the imperfect position, but the inability to place the patient in both horizontal and vertical positions in order to obtain pictures showing the mobility of the kidneys. Where it is possible to have the *x*-ray work carried out upon a cystoscopic table this should be done. The ordinary cystoscopic examining table, with seat and movable back and knee supports, can be utilized by placing the cassette containing the *x*-ray film (or plate) beneath the back at the proper place, but a table

without a seat and simply a long flat back to which the leg rests are attached is preferable in that the patient is more comfortable, and it is then possible to slide the *x*-ray plate up or down in any position desired for high or low urologic work. We have embodied this idea in our *x*-ray cystoscopic table which has the additional advantage that the position of the patient can be changed so that the first pyelogram can be taken in a horizontal or even Trendelenburg position and then the patient elevated quickly into a vertical position and a second picture taken to show the drop of the kidney resulting therefrom (Figs. 638 and 639).

This table can also be used for ordinary cystoscopy, since the flat diaphragm is waterproof, and also for perineal, renal, and abdominal operations.[1]

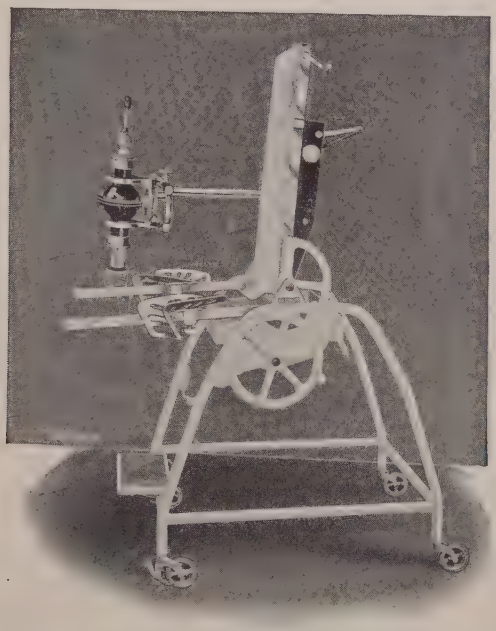


Fig. 639.—Young's table in vertical position for pyelograms to show drop of kidneys in this position. The side bars have been placed at right angles to the table top and patient sits on the thigh supports.

The *technic of pyelography* is as follows: All requisite specimens of urine having been obtained, a graduated burette about 1 cm. in diameter and holding 50 c.c., with a rubber tube 50 cm. long and provided with a conical metal tip is used. The burette is filled with sterile thorium nitrate (or sodium bromid or iodid), 15 per cent. solution, and the tube elevated to expel air. The conical tip is then inserted into the ureter catheter and the burette elevated 20 to 50 cm. above the level of the penis. The progress of the inflow of fluid is watched on the burette and the patient is told to notify the operator when a painful sensation is experienced in the region of the kidney. When this occurs the *x*-ray operator, who has made preliminary preparations by placing a film in a cassette at the proper place beneath the table, makes exposure in a horizontal position. As it is usually desirable to have a pyelogram also in a vertical position the patient is rapidly elevated by turning the wheel at the side of the table until he is in a sitting posture. The *x*-ray

[1] Young: Transactions of the American Urological Association, 1920, xii, 344–347.

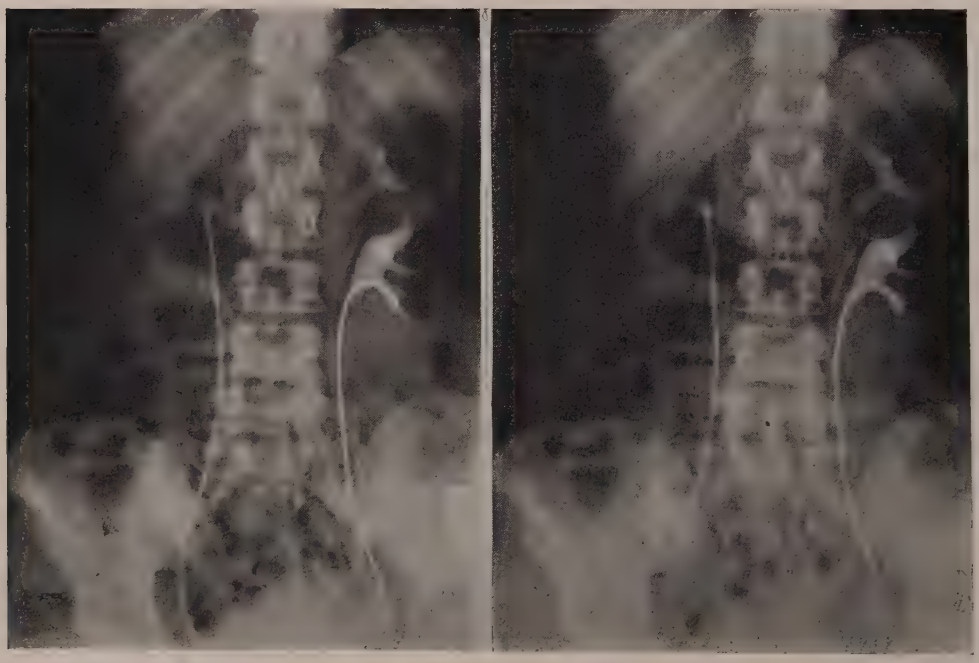
film is changed and the plate taken. In the meantime the burette with the pyelographic medium remains connected with the ureter catheter so as to keep the pelvis filled in a vertical position. Sometimes the pelvis fills better if the head is depressed to a Trendelenburg position.

After pyelography all the fluid should be allowed to drain off through the ureter catheter before it is withdrawn, and its escape may be facilitated by suction with a syringe. Having thoroughly evacuated the pelvis it is then washed out with some mild antiseptic solution (1:500 meroxyl; 1:1000 silver nitrate) after which the ureter catheter is withdrawn. This final lavage of the renal pelvis should always be carried out, as ureter catheterization is frequently done through an infected tract and, at best, is liable to flaws in aseptic technic. Where bilateral pyelography is to be carried out two burettes should be employed.

After ureter catheterization, especially when pyelography or pelvic lavage for treatment has been carried out, the patient should be placed on a couch, given water in abundance to drink and a hypodermic of morphin if spasm and pain occur. In some cases it is advisable to admit the patient to the hospital. Should serious reaction, suppression, or anuria occur after bilateral pyelography, energetic measures to relieve the spasm and induce urinary outflow should be undertaken (morphin, hot stupes, hypodermoclysis, etc.).

Assemblage of Data.—Having obtained a systematic and sufficiently thorough study of the case, the history, notes of examination, charts, microscopic, chemical, functional, and bacteriologic findings, and radiographs—plain and shadowgraphic—are assembled for examination. It is in this ability to assemble studies of such varying character that urology is remarkable. In no other field of medicine is it possible to have such a great array of data for consultation in making diagnoses of

Fig. 640.—Stereoscopic pyelogram showing double kidney and ureter. The two ureteral orifices are side by side in the bladder. Aside from the malformation kidneys were normal and uninfected.



obscure, deep-seated lesions; but although the data at hand are manifold, not infrequently great experience is required to elucidate the problems presented. These will be described at length at the proper places under the various diseases.

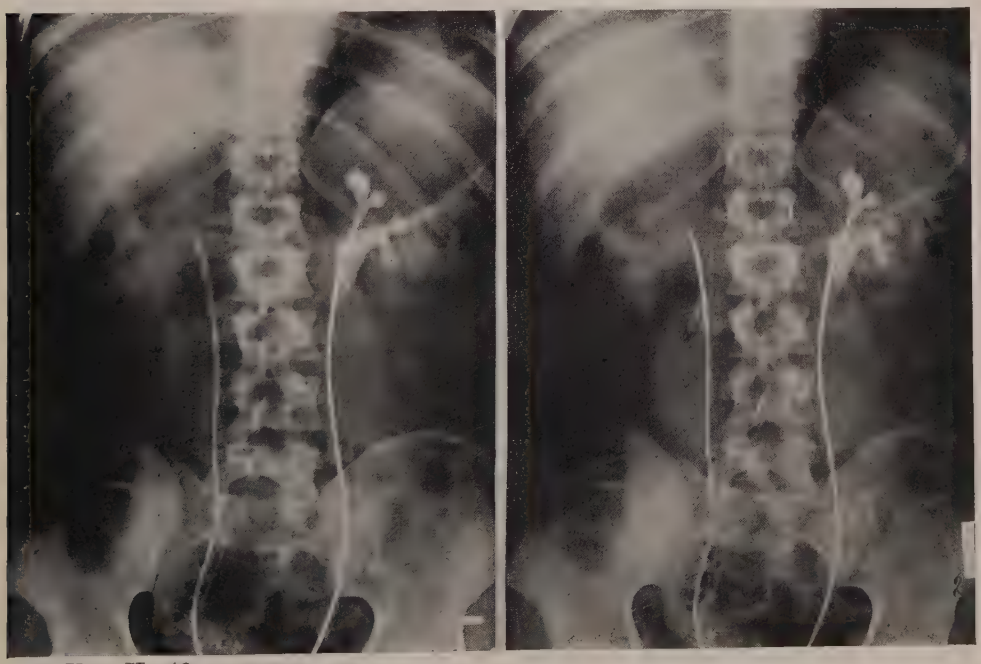
Fluoroscopy of the urinary tract may be used in the detection of calculi especially with the kidney exposed at operation.[1] It may also be used in the study of vesical diverticula, tumors of the bladder, ureteral stricture, and in certain pathologic conditions of the kidney. As a whole, however, the film or plate is far more satisfactory and produces a permanent record for future study. Unless called for by special conditions, fluoroscopy is usually not carried out.

Stereoscopic x-ray plates may also be used with splendid effect in showing the size and character of calculi, the shape of the renal pelvis and its calices, or vesical diverticula filled with shadowgraphic medium (Figs. 640–642). In order to make stereoscopic pictures successfully it is necessary that a plate holder in a fixed position be employed and that the tube be provided with the requisite stereoscopic movement. This has been provided for in our *x*-ray cystoscopic table, and very good stereoscopic pictures can thus be obtained. Our flat diaphragm, in which the grids run transversely, gives much more satisfactory stereoscopic pictures than the Bucky diaphragm, in which the grids run longitudinally.

Ureterography.—The contour of the ureter may be shown by filling it with various shadowgraphic media and taking the *x*-ray film or plate in the same manner as described for pyelography. When the ureter catheter has reached to the pelvis of the kidney the fluid will not, as a rule, flow down the ureter, but by withdrawing the catheter into the lower portion of the ureter a good shadowgraphic picture of the ureteral cavity can be obtained at the same time that pyelography is done. One

[1] Braasch and Carman: Journal of the American Medical Association, 1919, lxxiii, 1751, 1752.

Fig. 641.—Stereoscopic pyelogram showing pelvis which is normal except for a somewhat bifid character. Another interesting feature is the sacral spina bifida.



great advantage in carrying out the technic in this way is that a bifid ureter may be shown, whereas otherwise only that portion of the tract occupied by the catheter will appear. We have elsewhere recorded an interesting case where a serious error was made by catheterizing the lower half of a bifid ureter.[1] The one serious objection to withdrawing the catheter into the ureter is the inability to drain off the pyelographic medium.

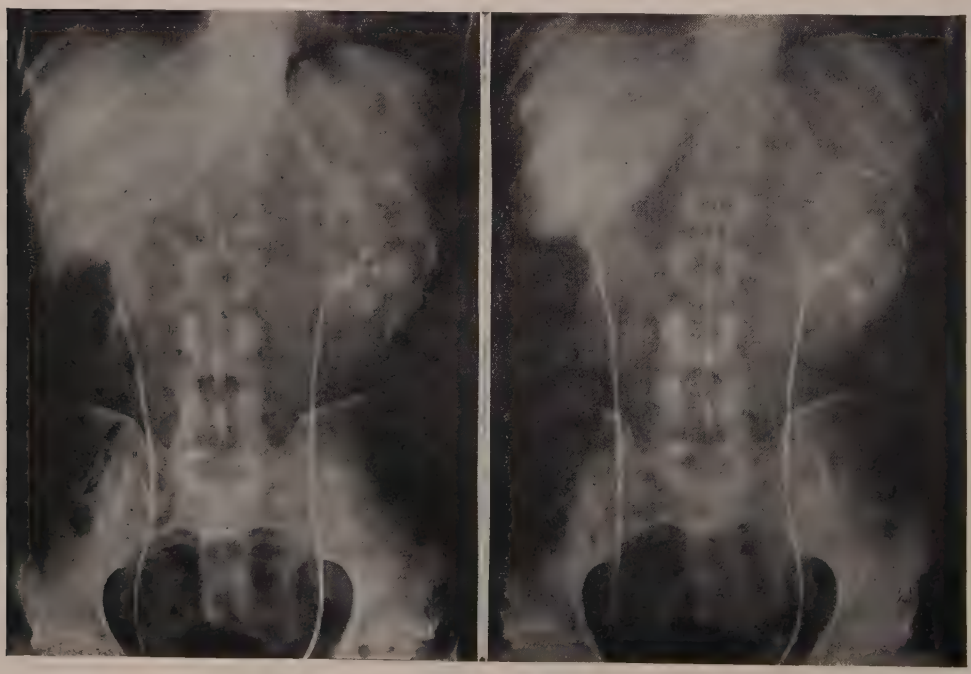
In the interpretation of a ureterogram it must be remembered that peristalsis is going on and waves of contraction will often be seen in the normal ureter. This will not infrequently lead to a false impression of one or more strictures being present. The movement of the ureter filled with shadowgraphic fluid during the exposure time will also give occasionally a much wider shadow than normal, thus leading to the false diagnosis of ureteral dilatation. Curves or kinks in the ureter may, when viewed from certain directions, give pictures suggesting more acute flexures than are really present. These conditions are described in detail elsewhere.

Ureterograms are not infrequently secured when taking the ordinary cystogram. This is due either to a reflux of the fluid from the bladder, the ureteral orifice being constantly patent, or it may be due to reverse peristalsis from the bladder.

Cystography.—*Cystograms* are obtained by filling the bladder with shadowgraphic media either by hydraulic pressure or through a catheter. We usually employ a 15 per cent. thorium nitrate solution, but sodium bromid or iodid may also be used as well as various silver preparations. In the normal bladder when distended the radiograph shows as a globular shadow. As the bladder empties the

[1] Young: Johns Hopkins Hospital Reports, xiii, 1906, 447–454.

Fig. 642.—Stereoscopic pyelogram showing the value of this procedure in differentiating masses not connected with the kidney. The pyelogram, while showing some effects of pressure from the tumor, is perfectly normal. Manipulation of the stereoscope shows that the tumor, which is a calcified cyst, is anterior to the kidney. The exact nature of this cyst was not determined.



shadow becomes progressively more oval and flattened and finally is triangular in shape when only the trigone is covered with a thin layer of fluid. If the prostatic orifice is open, as in tabes or with congenital valves of the posterior urethra or after suprapubic prostatectomy, the posterior urethra may appear as a gourd-like neck to the vesical shadow. In such cases the urethral shadow is not seen beyond the apex of the prostate. Where the external sphincter is paralyzed, or dilated as a result of traumatism, the entire urethra may be seen distended with fluid when the cystogram is taken. Where the bladder has been filled by hydraulic pressure without the use of a catheter, unless the fluid is allowed to escape from the urethra, simultaneous cystograms and urethrograms may be obtained even in normal cases. Cystograms may also be taken with the bladder filled with air; this method is particularly valuable in bladder tumors. It may also be used for a diverticulum, but the shadowgraphic media are better in the latter case.

Diverticula may be brought out in contrast by the following technic.[1] The bladder is filled through a catheter with 15 per cent. thorium or sodium iodid solution. The diverticula are thus filled at the same time. The fluid is then allowed to escape from the bladder through the catheter, but not sufficiently to empty the diverticulum. The bladder is then filled with a 3 or 5 per cent. solution of the shadowgraphic media and an *x*-ray immediately taken before the solution in the diverticulum has a chance to become greatly diluted from the weaker solution in the bladder. This method may give beautiful contrasts between the diverticulum and the bladder, and is very helpful when the diverticula are behind the bladder where they would usually be obscured by the vesical shadow. Instead of the weak solution, the second injection may be of air, the diverticula remaining filled as before. This is also an excellent method.

Shadowgraph ureter catheters may also be employed to show the dimensions and positions of diverticula. One simply inserts the shadowgraphic catheter into the orifice of the diverticulum and continues to push it in until most of the catheter is rolled up within the diverticulum. If further diverticula are present, this may be repeated several times.

Vesiculography.—*Vesiculograms* are made by injecting the seminal vesicles with shadowgraphic media. The value of this method was brought out by Picker,[2] who introduced silver suspensions through the vas deferens in the groin and thus obtained excellent pictures. Belfield[3] extended the method to the treatment of infectious conditions of the ampullæ and seminal vesicles with excellent results. As a rule, 5 or 10 per cent. solution of argyrol is employed. The technic is described under the operation of vasotomy. The same results can be obtained by injections of the ejaculatory ducts through the urethroscope.[4] Using our combined *x*-ray cystoscopic table, the urethroscope is introduced and the verumontanum brought into the field. With special probe-dilators the utricle and ejaculatory ducts are examined and *x*-ray films taken if desired (Fig. 113). The probe after passing about 2 cm. usually meets the point of juncture of the ampulla and seminal vesicle. If the instrument is passed directly upward it usually enters the vas deferens. If passed somewhat outward, it enters usually the seminal vesicle. By using a

[1] La Rose: Journal of Urology, 1924, xii, 185–188.
[2] Fourteenth International Medical Congress, London, 1911.
[3] Surgery, Gynecology, and Obstetrics, 1913, xvi, 569.
[4] Young and Waters: Johns Hopkins Hospital Bulletin, 1920, xxxi, 12, 13.

syringe and special cannula the ejaculatory ducts may easily be catheterized and if the cannula is introduced for a distance of about 2 cm. or more and an injection of 10 per cent. argyrol made, a shadowgraph of the ampulla and vas, often extending as far as the internal ring, can generally be obtained. If the tube is passed outward, a shadowgraph of the seminal vesicle alone may be obtained. Where the tube is introduced only a short distance into the ejaculatory duct the shadowgraphic medium may penetrate either the ampulla or the seminal vesicles, or both. Simultaneous bilateral vesiculograms may be obtained by using a bifid tube by means of which the ejaculatory ducts are catheterized, one after the other, and then simultaneously injected.

Vesiculograms may be used to demonstrate pathologic conditions in the seminal tract, dilatations, strictures, and complete blockage of the seminal vesicles and ampullæ. The method is, therefore, of importance, not only in inflammatory conditions, but also in cases of sterility where epididymovasostomy is contemplated. Of more importance, however, is the use of mercurochrome ($\frac{1}{4}$ per cent.) or argyrol (1 per cent.) injections, into the vesicles and ampullæ, in chronic infections. We have employed a mixture of mercurochrome and thorium to obtain vesiculograms and germicidal activity simultaneously.

Urethrography.—*Urethrograms*, as previously described, may be of value in disclosing diverticula, fistulæ, irregular dilatations of the urethra, pouch formation, weakened sphincters with incontinence of urine, foreign bodies, stricture, etc.

The use of a shadowgraphic medium is of very great value in all portions of the genito-urinary tract, and has been of wonderful assistance in diagnostic work. The *x*-ray is of very great value during certain operations upon the urinary tract, particularly in the removal of renal calculi, foreign bodies, bullets, shell fragments, etc. It has also been employed in stone crushing, the calculus being grasped by the lithotrite while directed by the fluoroscope. The use of the *x*-ray for the treatment of malignant diseases of the bladder, prostate, and urethra is also of very great importance and is discussed at length elsewhere.

Operative Cystoscopy and Endoscopy.—In order thoroughly to present the possibilities of endoscopy and cystoscopy, it will be necessary to go back briefly into the history of this interesting field of medicine. Apparently the first serious attempt to inspect the interior of the urethra and the bladder was made by Bozzini of Frankfort in 1806. Using a metal tube and a crude lighting apparatus of tallow candles, Bozzini made the great beginning which has ended in the perfection of modern cystoscopy.

He was followed in 1826 by Ségellas, who improved his crude instruments; but still the materials at hand were too ineffective for any real progress to be made, and it was not until 1853 that Désormeaux brought out the first practical endoscope by means of a tube, a lamp, and intervening reflectors. With this instrument he diagnosed and treated urethritis, carried out internal urethrotomy under the guidance of the eye, and removed a papilloma from the urethra.

In 1861 Bruck took advantage of the progress made in electricity to design an instrument lighted with a platinum loop heated by an electric current, to view the interior of the bladder. It was his instrument which Nitze used as a basis of his great work. Nitze improved the water-cooling system, by which it was possible to maintain the cystoscope in the human bladder, and working with Leiter of Vienna, who developed the lens system, was able to study successfully the normal

and diseased bladder, and made the first real advances toward modern cystoscopy. Three years later, 1879, Edison brought out the electric lamp, and Newman of Glasgow in 1883 and Mayo-Robson of Leeds in 1885 made use of minute Edison lamps to view the interior of the bladder. Two years later Nitze working with Hartwig in Berlin and Leiter in Vienna, simultaneously, brought out cystoscopes lighted by a small electric lamp, and with a telescope which is practically the instrument of today.

Nitze presented three types of cystoscopes: (1) with vision direct so that the posterior wall was under inspection; (2) with right angle vision, which he recommended for study of the base and lateral walls of the bladder; and (3) a retrograde oblique cystoscope for the anterior wall of the bladder. These instruments rapidly gained in favor and wide-spread usage. The following year, 1888, Brenner added to the posterior surface of Nitze's direct cystoscope a tube to carry a catheter and with this instrument succeeded in catheterizing the ureter in a female. He also attempted catheterization in male cases, but did not succeed. Five years later James Brown[1] of the Johns Hopkins Hospital, modified the Brenner technic by the introduction of a curved spring stylet which, when introduced within the ureter catheter, gave it the curve necessary to make it possible to introduce it into the ureter in the male. With this instrument, on June 9, 1893, Brown first succeeded in catheterizing the ureter in the male subject. He was able to make a diagnosis of pyonephrosis and Halsted confirmed the diagnosis by carrying out nephrectomy, apparently the first kidney operation following accurate cystoscopic diagnosis in the male.

In 1895 Casper apparently devised the first successful catheterizing cystoscope with right angle vision. By means of a slide which covered a groove for the catheter on the exterior of the cystoscope, Casper was able to move the catheter by pushing in the slide and thus bending it at the point from which it emerged from the cannula. With this instrument for many years he continued to do accurate diagnostic work in the upper urinary passages. It was with this instrument that we first learned ureter catheterization. At first only one catheter was carried. To catheterize the second ureter it was necessary to withdraw the slide, elevate the catheter, reintroduce the slide, thus throwing the catheter into the ureter. The second catheter was then introduced through the cannula and the other ureter catheterized. By repeating the maneuver this catheter could also be thrown out of the cannula by withdrawing the slide, after which the entire cystoscope could be withdrawn, leaving the two ureter catheters in place. Casper's work was unquestionably of great value in the development of cystoscopy and soon led to serious battles between him and Nitze similar to those which had occurred between Nitze and Leiter.

One of the most important additions to the cystoscope was made by Albarran in 1897. Albarran devised a hinged lever or finger, which could be operated from without. This lever lay immediately beneath the catheter as it emerged from the tube in the bladder and with this mechanism it was possible to move the catheter into the proper direction for catheterizing the ureter. This mechanism was soon adopted by Nitze and has been embodied in all modern right angle ureter catheterizing cystoscopes. The operation has now become so simple that very little experience is required to become fairly expert in ureter catheterization.

[1] Johns Hopkins Hospital Bulletin, 1893, iv, 73, 74; 1895, vi, 12–15.

Nitze continued to experiment and bring out new types of instruments, one of which he called an evacuating cystoscope. This instrument consisted of an outer sheath which carried the lamp and electric connections and an inner telescope, which could be withdrawn. Through the outer tube the bladder was washed clean and fragments of stone, tumor, etc., evacuated.

About this time Brown of New York presented a direct evacuating catheterizing cystoscope and soon added another barrel and made it a double catheterizing instrument. Brown also provided an indirect double catheterizing cystoscope.

Other American urologists, among whom are Brown, Otis, Lewis, Buerger, McCarthy, and Gordon, brought out various modifications and innovations which have made the American cystoscope one of the most perfect instruments ever constructed. Working with them was a great mechanic, Reinhold Wappler, to whom much credit is due, just as Leiter in Vienna, Löwenstein and Wolf in Berlin, and Collin and Drapier in France deserve much credit for advances in cystoscopic instruments.

Another form of direct cystoscopy came as a result of pioneer work by Simon and Pawlik who catheterized the ureters in women by palpation through the vaginal wall. In 1894 Kelly modified the speculums of Gruenfeld and Newman and using the knee-chest position of Pawlik, found that the bladder would fill with air and afford a good view of the ureteral orifices.

In 1893, several months after James Brown's epoch making catheterization of the male ureter, Kelly[1] succeeded in catheterizing female ureters under direct vision through an open tubular endoscope, the bladder being filled with air, and lighted by a head mirror from an electric lamp without. Kelly followed this up with a splendid series of papers which opened up the field of urology in the female, and added many brilliant feats of cystoscopic diagnosis and operative treatment.

In recent years the open tube, unprovided with telescopes, has been modified in various ways by Millet, Elsner, Braasch, Greenberg, Cullen, Luys, and others. Some of these continue to operate with the bladder filled with air, either by placing the patient in the knee-chest position used by Kelly or in the inverted dorsal position of Luys. Braasch and others employ a water medium and close the end of the instrument with a glass plate through which ureter catheterization or minor operations may be conducted.

We have not the space here to go into the multitude of ingenious and interesting instruments which have been evolved.

Operative Cystoscopy.—Early in the history of cystoscopy many instruments were evolved for carrying out various operating procedures within the bladder. Nitze was most ingenious in devising forceps, cauteries, snares, stone crushers, etc. One of his greatest triumphs was an instrument with which he was able to snare a polypoid tumor within the bladder, cauterizing the pedicle as he cut it off and then with the beak of the instrument as another cautery point, sear the bleeding pedicle. The second was a cystoscopic "kodak," with which he was able to take ten successive views of the vesical interior.

Casper, Lewis, Buerger, Beer, McCarthy, Caulk, and others have added many ingenious instruments to be used in conjunction with cystoscopy. With these it is possible to remove specimens for pathologic study, foreign bodies and stone

[1] American Journal of Obstetrics, 1894, xxix, 1–19.

fragments, to divide ureteral orifices, to fulgurate bladder tumors, to crush small calculi and evacuate them, and to introduce dilating instruments into the ureter.

We may be pardoned for mentioning here operative cystoscopes which have been devised at this clinic. The cystoscopic rongeur[1] (Fig. 636) provides a strong surgical instrument which can be opened up and used to grasp large tumor masses, prostatic lobes, foreign bodies, small calculi, etc., and to remove them from the bladder. By means of a small straight cystoscope which can be withdrawn for irrigation or evacuation, an excellent view of the bladder is obtained. When an object to be removed is found, the outer sheath carrying the blades is rotated until they come into view in the center of the field. With a special centering device outside it is simply necessary to fix the blades in this position, by means of a set screw externally, so that when opened and closed they will come together invariably in the center of the field of vision. With this centering device accurate manipulations are possible so that no difficulty is experienced in picking up foreign bodies or tumor masses and removing them from the bladder. Cases are cited elsewhere. The cystoscopi crongeur has been made with blades of different type, some of which work within each other like a punch, others serrated in the form of forceps, and another provided with an electrocautery within one blade by means of which simultaneous cauterization and removal of bladder specimens is carried out. Kretschmer has also used it for crushing small stone fragments by adding solid blades. Lowsley has devised a rongeur with McCarthy's cystoscope.

The second instrument devised here[2] was the cystoscopic evacuating lithotrite shown in Fig. 781. By means of this instrument, which is constructed as a powerful lithotrite to meet the most exacting requirements, it is possible to crush and evacuate calculi, and, when desirable, to introduce a long cystoscope to search for fragments and determine whether the operation is complete.

In 1914, making use of the small straight No. 15 cystoscope used in our rongeur, we devised a series of radium instruments. With the first instrument (Figs. 382, 383) a gold or platinum tube loaded with radium (generally 100 mg.) can be placed upon a tumor of the bladder or of the prostate under visual inspection and held there by means of a cystoscopic clamp. The clamp is attached to the table and grasps the radium applicator by the bulbous enlargement, as shown in Fig. 384. With this instrument it was possible, for the first time, to apply radium accurately within the bladder and to hold it in position for a sufficient time (generally one hour). Beaks of different lengths, carrying two tubes of radium, 100 mg. each, tandem, end to end (Fig. 637, H), side by side (Fig. 637, I), have been devised. The success which attended its use in the bladder caused us to apply the same principles to the treatment of tumors through the urethra and rectum, omitting the cystoscope, but fastening the radium applicator to the table by means of the same cystoscopic clamp. For tumors situated on the lateral walls of the bladder a second instrument has been devised (Figs. 385, 386, 637, J). With this instrument, which operates in the form of a parallelogram, a silver tube containing 100 or 200 mg. of radium can be placed upon a tumor 1 inch or more from the center

[1] Young: Transactions of the American Urological Association (1909), Brookline, 1910, iii, 227–231.

[2] Young: Transactions of the American Association of Genito-Urinary Surgeons, 1910, v, 216–231.

of the bladder with impunity and held there by the cystoscopic clamp fixed to the table. A third and fourth form of radium-bearing cystoscope are shown in Figs. 637, K, L, 387–390. They were devised for applying radium to the anterior and posterior walls of the bladder and have had considerable usage, but practical experience has shown that the first and second forms described (Figs. 382–386) are sufficient for practical purposes. The technic of employing these instruments has been described in Chapter VIII.

Around the straight cystoscope it is possible to build any number of mechanical devices for intravesical maneuvers. We have constructed a catheterizing cystoscope of this type and subsequently Ringleb devised a similar instrument. Small and large evacuating tubes may be utilized with a straight cystoscope for evacuation cystoscopy (Fig. 637, B, C). These are valuable where severe bleeding or large clots are present. The evacuating tubes can also be used for evacuation of calculi. The straight cystoscope may be used with a special sheath carrying a large canal for bougies or insulated electrodes. It is with the operating cystoscope that wax-tip catheters are passed, as described fully in Chapter VI, and with this instrument it is possible to pass them with less danger of acquiring scratch marks before entering the ureter (Fig. 637, G).

A special fulgurating cystoscope for carrying very powerful high frequency currents to tumors, etc., has also been devised to go with our straight cystoscope.

We have recently devised a cystoscope (Fig. 636) in which the irrigating cocks and electrical connection are stationary, the instrument revolving within them. It has various other features which increase its convenience and lessen the likelihood of breaks in aseptic technic. It can be used either for catheterization or operating.

In the recent instruments of McCarthy, Lewis, Lowsley, Gordon, and others, various ingenious additions to the cystoscopic armamentarium have been made. The field is limitless for inventive urologists, and the future will undoubtedly see the production of many valuable and more effective instruments for operative cystoscopy.

Water vs. air as a cystoscopic medium has been the subject of much discussion. The technic with water is simpler. The patient may lie horizontally on his back and the various cystoscopic manipulations are carried out with great ease. When, however, there is marked hemorrhage cloudiness of the fluid may interfere greatly. When direct application of caustics and other drugs is to be undertaken the fluid interferes. When fulguration is to be carried out, the presence of water materially reduces the destructive effect. With the bladder filled with air, drug applications can be made with greater simplicity, fulguration and cauterization are more effective, and bleeding need not obscure the vision. There are, however, great inconveniences with air cystoscopy in that, if the position of Kelly is used, the female patient finds it very uncomfortable to remain on the chest and knees, and with the male it is impossible. With the inverted dorsal position of Luys the patient is not so uncomfortable and the method may be used in both male and female, but here again the views obtained with the direct tubular instrument are far less satisfactory than those obtained with the wide angle telescope, either direct or right angled. To catheterize the ureters it is necessary to deflect the instrument far to one side in order to see the orifice and to get the ureter catheter in line with the course of the ureters. On this account air is used by few very operators as a cystoscopic medium.

Water may, however, be used in somewhat similar instruments. Braasch uses water with a direct observation and catheterizing cystoscope which has no telescope and Greenberg uses an endoscopic tube carrying a telescope for either water or air as the occasion requires. It is probable that in the near future endoscopy of the bladder with both air and water and with a simple straight tubular instrument will receive further attention.

For a very complete discussion of the development of cystoscopy see The History of the Development of Urology as a Specialty, by Thomas T. Moore, Journal of Urology, 1923, x, 99–120; also Lewis, B., American Journal of Urology, 1907, iii, 289–297; Pilcher, L. S., Annals of Surgery, xxxi, 100–118; and Nitze, M., Wiener Medicinische Wochenschrift, 1879, xxix, 779–806.

CHAPTER XIV

OPERATIONS ON THE KIDNEY

ANESTHESIA

The problem of anesthesia in operations upon the urogenital tract is an important one. Thanks to the great improvement in the technic of anesthesia, we no longer have the frequent anesthetic deaths that formerly occurred.

The kinds of anesthesia which are suitable for this work may be classified as follows: (1) General anesthesia. For this purpose nitrous oxid and oxygen, nitrous oxid and oxygen with small addition of ether, ether alone, or the newer anesthetics—ethylene or acetylene—may be used. (2) Spinal anesthesia. Here novocain or stovain may be used. (3) Regional anesthesia or nerve blocking. Novocain (procain) is usually employed for this purpose. (4) Local anesthesia. Here also novocain is the most suitable. It may include either infiltration of the operative field itself or the infiltration of a linear area surrounding the operative field in such a manner as to anesthetize all nerves leading into it.

General anesthesia is indicated in a large proportion of urogenital operations. It is very difficult to perform operations on the kidney satisfactorily under any other form of anesthesia. A nervous or apprehensive attitude of the patient may make general anesthesia very desirable. The most useful form of general anesthesia is that given by nitrous oxid and oxygen. This should be administered by a trained anesthetist, and a tight-fitting mask should be used with slight increase of pressure and rebreathing. It is then possible to obtain entirely satisfactory relaxation in a large majority of patients without the addition of ether. Where this is impossible for any reason a small quantity of ether may be added from time to time by means of the drop apparatus forming a part of most anesthesia outfits, or by the addition of a measured quantity of ether vapor as is possible with some outfits. Straight ether anesthesia is no longer used in our clinic except in cases with high blood-pressure in which the additional increase of blood-pressure caused by nitrous oxid might be harmful to the patient. We feel in these cases that the use of ether anesthesia is extremely valuable. Very satisfactory anesthesia can be obtained with ethylene and oxygen, but we have hesitated to use this form of anesthesia as a routine procedure since it is so often desirable in operations on the urogenital tract to employ the actual cautery, and there is a certain danger of explosion with ethylene. We have had no personal experience with acetylene anesthesia.

At our request Miss Margaret Boise, anesthetist to the Johns Hopkins Hospital, has studied the records of 500 successive perineal prostatectomies performed under general anesthesia. These 500 prostatectomies were done by many different operators, and show a mortality of 4 per cent. Figure 643 shows the proportion of cases in which each type of anesthesia was employed. It will be seen that nitrous oxid was used in the great majority, but in more than one-half of them it was considered necessary to add a small quantity of ether. Figure 644 indicates

the average number of days in the hospital after operation of patients, arranged according to the form of anesthetic employed, and also according to age groups. It will be seen that with little exception the stay in the hospital after operation was practically independent of the form of anesthesia used. The larger figure for gas and ether anesthesia in the patients more than eighty years old is due to the fact that this was a very small group and is probably accidental. The other half of the table indicates clearly that factors other than anesthesia, such as, in this instance, the hemoglobin reading before operation, influenced the postoperative stay in the hospital much more than the form of anesthetic used. Throughout the table it is the general rule that patients with normal or nearly normal hemoglobin figures before operation remain in the hospital a much shorter time after operation than those who are anemic before operation. Figure 645 indicates the mortality rate in percentage arranged according to the age groups. This shows clearly that disregarding other factors the risk of a fatal termination after operation increases with advancing years and more rapidly after the age of eighty.

Each of the 500 cases was classified before operation as a good, fair, or poor risk according to the general condition, age, complicating lesions, obesity, etc. On this basis 225 cases were in good condition, 198 in fair condition and 77 in poor condition. Figure 646 shows the percentage of postoperative deaths occurring in each of these groups, indicating clearly that the pre-operative estimate of the patient's condition is a rather accurate forecast of the risk which he runs of a fatal termination. It is striking, however, that patients considered in fair condition showed only a slightly greater mortality than those considered in good condition.

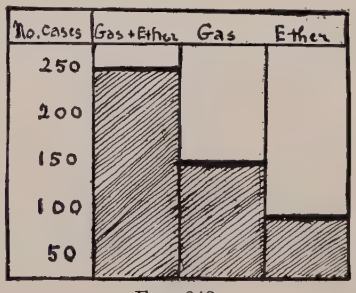


Fig. 643.

The blood-pressure was taken in all of these cases, and since they are all elderly men, it is not surprising that 258 were found to show blood-pressures higher than 140 mm. mercury. Sixteen of these showed blood-pressures of over 200 mm. mercury. Of these 16, 12 were anesthetized with ether and 4 with nitrous oxid and oxygen with addition of some ether. All of them recovered, 15 without incident, and 1 after an attack of bronchitis. Of the 500 patients, 20 died in the hospital. These deaths were due to the following causes:

TABLE 154

Cause of Death

Thrombosis or embolism	5
Pneumonia	3
Heart failure	3
Septicemia	2
"General weakness"	2
Shock	1
Hemorrhage	1
Intestinal obstruction	1
Perforation of bladder carcinoma	1
Coronary sclerosis	1
Total	20

The deaths occurring from hemorrhage, "general weakness," septicemia, intestinal obstruction, bladder carcinoma, and coronary sclerosis could not be charged against the anesthetic in any way. Of the 3 deaths from pneumonia, 2 occurred five days after the operation. Each of these had received gas-ether anesthesia. The third died twenty-nine days after operation, the anesthetic in this case having been nitrous oxid and oxygen. There are only two other cases of pneumonia in the series, one of whom received straight gas, and the other gas-ether. Both of these patients recovered. In the remainder where death occured shortly after operation, the rôle

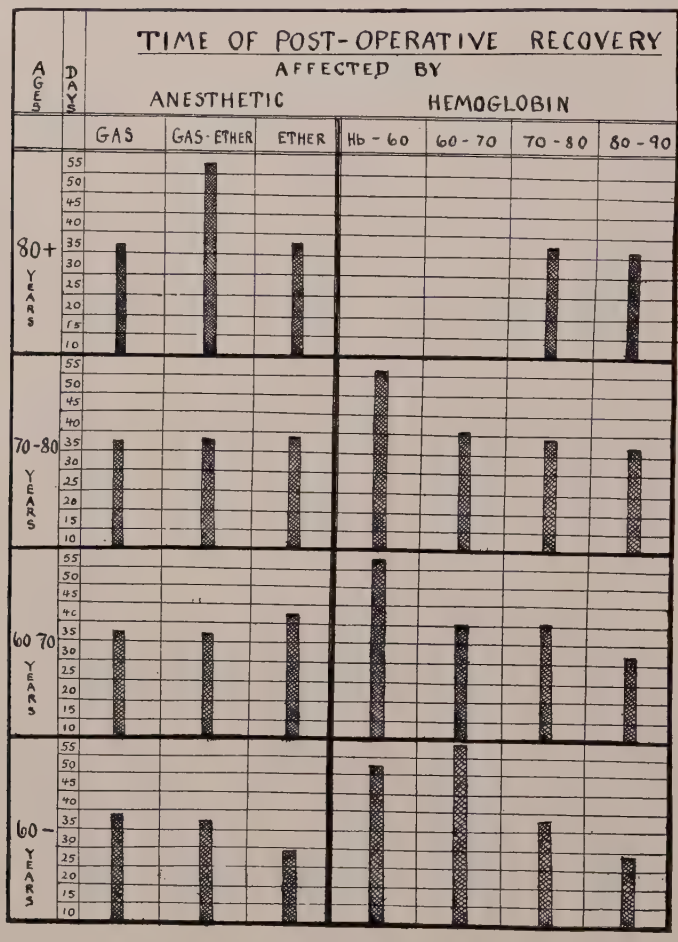


Fig. 644.

played by the anesthetic is at least a doubtful one and there is no special reason for attributing these deaths to it. In all of the 480 cases where recovery occurred it was uneventful except in 10. The complications were: pneumonia, 2 (as mentioned above); bronchitis, 3; cardiac complications, 4; shock, 1. In each case the convalescence was somewhat delayed by the complication.

In cases where ether was given in addition to the nitrous oxid-oxygen mixture, the average amount of ether used in each case was $\frac{1}{2}$ ounce. The average time of operation in these 500 cases was forty minutes.

Spinal Anesthesia.—We have performed a number of operations under spinal anesthesia, including a few on the kidney, in which the anesthesia was quite satisfactory. The technic of spinal anesthesia is simple and the result is very satisfactory, as a rule, but we have seen an occasional case in which death occurred rapidly after the injection was made. These cases are very tragic and the injection once made, nothing can be done effectively to combat the evil effects. We feel, therefore, that, in spite of the many advantages present during a successful spinal anesthesia, the danger of these occasional fatal results is sufficient to con-

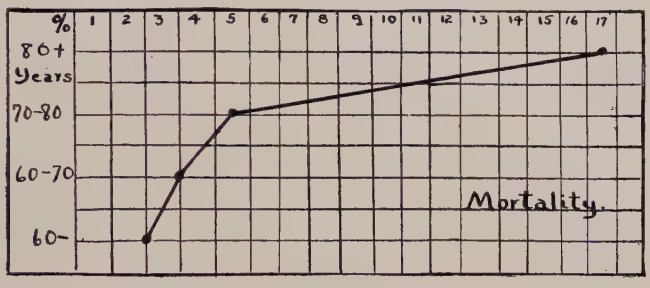


Fig. 645.

demn it as a routine procedure. It may be, however, that in an occasional case nothing else will serve as well, and the attendant risk may thereby be justified. In the cases in which we have employed spinal anesthesia both novocain and stovain have been used with apparently equally satisfactory results.

Regional Anesthesia.—This form of anesthesia has been greatly developed in recent years. The reader is referred to Labat and de Butler d'Ormond. The procedures employed usually include paravertebral injections by means of which the spinal nerves are anesthetized at the points at which they emerge from the vertebral column. The only exception is in the case of the caudal epidural anesthesia in

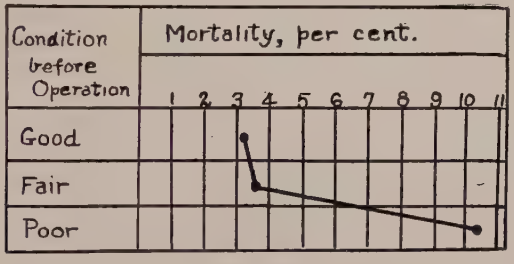


Fig. 646.

which the tissues outside the dura in the sacral canal are infiltrated by means of a needle introduced through the terminal sacral hiatus. Paravertebral anesthesia is very satisfactory in the hands of those who have had much practice. It will readily be seen that the task of finding the proper point of injection opposite each nerve root by means of a needle is not a simple one and requires both skill and time for its performance. To anesthetize any region satisfactorily several roots, usually at least 4 or 5, must be anesthetized. The proper point of injection for each region can readily be seen by consulting any standard work on anatomy. For operations on the kidney it has been found that the paravertebral injections give

anesthesia which is perfectly satisfactory for the abdominal wall, allowing exposure of the kidney, but when any manipulations of the kidney itself are begun with resultant traction on the pedicle, pain is felt. In an effort to meet this situation the splanchnic nerves in the region of the celiac plexus have been injected. This is possible by using long needles which are inserted alongside of the bodies of the vertebræ in the costovertebral angle somewhat lower on the right side than on the left. This, however, is a delicate procedure and may easily fail by reason of errors in the direction or in the depth of the insertion of the needle. In addition, there is a certain danger of penetrating the aorta, vena cava, renal arteries, renal veins, or intestinal tract. Meeker has found anesthesia unsatisfactory in many of his 42 cases. This procedure is seldom employed, owing to the skill and experience necessary, and many surgeons who employ local anesthesia for kidney operations find it necessary to have general anesthesia induced during the manipulations on the kidney itself. The nervous strain on the patient and on the surgeon, together with the struggle which may occur, probably counteract the slight benefits which ensue from the shortening of the period of general anesthesia allowed by the local anesthesia of the abdominal wall. Some are able to continue by using "ether suggestion," with 10 to 15 drops of ether. We do not attempt to utilize local or regional anesthesia for kidney operations. With a skilful anesthetist who employs gas and oxygen with the addition of little or no ether we feel the danger is minimal, even in cases of tuberculosis. If the condition of the lungs is such that general anesthesia is absolutely contraindicated, spinal anesthesia is justifiable for certain renal operations. Paravertebral injections may be the method of choice in some cases. For operations upon the bladder the use of regional anesthesia involves the injection of a large number of spinal roots, since the lumbar nerves must be attacked in order to produce anesthesia of the anterior abdominal wall and the sacral roots as well for the anesthesia of the bladder itself and the regions adjoining it. This makes the procedure rather time consuming, but satisfactory results may be obtained.

Epidural Caudal Anesthesia.—Practically all perineal operations can be satisfactorily done under epidural anesthesia (also known as extradural, sacral, and caudal anesthesia). By this term is meant a single injection of the anesthetizing solution through the sacral hiatus into the extradural space. Some have used this injection in combination with injections directly into the sacral nerves at their point of exit from the sacral foramina (parasacral anesthesia), but we have found this procedure not only time consuming but also unnecessary.

The technic of administration is simple, once the landmarks have been located. Normally, the laminæ of the first four sacral vertebræ unite to form the four sacral spinous processes. The laminæ of the fifth sacral vertebra do not unite and can be palpated as definite tuberosities on either side just lateral to the midline. These tuberosities are known as the sacral cornua. The resulting bony defect in the roof of the vertebral canal is covered by a dense fibrous membrane and is termed the sacral hiatus. The spinous process of the fourth sacral vertebra and the two sacral cornua form a triangle. The needle is introduced through the skin at the base of this triangle in the midline and is directed upward and ventrally until the membrane covering the sacral hiatus is pierced. The handle of the needle is then depressed and by gentle pressure the needle can be introduced into the vertebral canal as far as desired. Not infrequently anomalies of the sacrum are encountered, but these rarely interfere with the administration of the solution.

There has been considerable variation in the dosage and concentration of the anesthetizing solution. We have obtained the best results from injections of 15 to 20 c.c. of 3 per cent. solution of procain. Complete anesthesia usually occurs within fifteen minutes following injection. The anesthetized area includes the perineum, anus, urethra, neck of bladder, the posterior surface of the scrotum and a variable area on the inner surface of the thighs. The duration of the anesthesia is from one to two hours.

Frequent blood-pressure determinations as well as records of pulse and respiratory rate should be made during all operations under epidural anesthesia. Not infrequently the blood-pressure begins falling immediately after the administration of the anesthetic. An intramuscular injection of 5 to 10 minims of 1:1000 adrenalin should be given when this is noted.

Experimental studies on the cadaver, as well as a careful summary of the clinical cases in which epidural anesthesia was used in our clinic, were made by Shaw.[1] These show that the best results were obtained by using 15 to 20 c.c. of 3 per cent. procain. In the cases in which a large amount of 1 per cent. solution (30 to 50 c.c.) was used the incidence of reactions was high. Many of these reactions were not detectable except by the frequent determinations of blood-pressure during the operation. A typical severe reaction consists in a fall of blood-pressure, pulse-rate, cyanosis, and in extreme cases vomiting and even unconsciousness. These patients with reactions responded well to adrenalin, an injection of 10 mm. of a 1 : 1000 solution usually being sufficient to bring pulse and blood-pressure back to normal. The rationale of using a small amount of concentrated solution was proved by experiments on the cadaver, which showed that 20 c.c. fills the sacral canal and any excess of this amount passes upward to the lumbar region of the vertebral canal.

We have done approximately 100 perineal prostatectomies under epidural anesthesia. In at least 90 per cent. of these cases the operation was performed without the patients suffering any pain. In the remaining cases it was necessary to give a small amount of nitrous oxid or ether. It was noticeable that the quantity of general anesthetic required in these cases of partial failure was much less than in those that had not received the caudal injection. Practically all the failures occurred in apprehensive or uncoöperative individuals, making it difficult to determine the degree of pain present. There was one death in this series. The patient died suddenly before the prostate was reached, forty minutes after the procain had been injected. Autopsy showed an old organized mural thrombus in the left ventricle and coronary embolism. The anesthetic certainly could not be held responsible for death in this case.

Epidural anesthesia has many advantages. During the operation the musculature of the perineum is relaxed, greatly facilitating the exposure and manipulation of the tissues. Nausea and vomiting, seen so frequently after general anesthesia, are rare. The incidence of postoperative pneumonia is practically nil. There is little or no shock and the patient can resume a full diet the day following operation. For operations on the bladder it is often possible to combine epidural caudal anesthesia with local anesthesia of the abdominal wall with success.

Local anesthesia may be used very successfully in many urogenital operations, especially those on the penis and scrotum. The lower abdomen is also a favorable

[1] To be published in the Journal of Urology.

site, provided that no attack on the deeper structures of the pelvis is contemplated. For the abdominal wall it is more satisfactory to infiltrate a linear area so placed as to block off the nerves supplying the region to be incised than it is to attempt local infiltration of the entire region. Since the nerves supplying the suprapubic area run obliquely downward around the abdominal wall the procedure of choice is to infiltrate a linear area lateral to the point at which the incision is to be made and extending upward considerably further than the upper end of the incision. As there are numerous nerve-fibers which cross the midline both sides of the abdomen should be infiltrated unless the incision is to be made a very considerable distance from the midline. The bladder must be infiltrated in the median line, and after cystotomy local injections around and into the region to be attacked are made. Prostatectomy can thus be carried out very successfully. For operations on the scrotum anesthesia is best induced by introducing a needle at about 5 or 6 points at the base of the scrotum and infiltrating a zone at this point which blocks all the nerves leading into the scrotum. After this has been done the needle should be inserted into the spermatic cord just below the external inguinal ring and the cord thoroughly infiltrated. By this means it will be found possible to perform epididymectomy, castration, and operations for hydrocele and varicocele without difficulty. If pain is felt after the operation has begun, the spermatic cord will usually be found responsible and may be further and more accurately infiltrated after it has been exposed. It is well to use a short-pointed needle in order to avoid puncturing the veins of the pampiniform plexus. The penis is anesthetized in a similar manner by three or four injections made at different points around its circumference at the root. This is the method customarily used for circumcision except in very small children, where a general anesthetic is necessary. For operations on the penis and scrotum which are made in combination with perineal or suprapubic operations on other organs it must be remembered that epidural anesthesia does not anesthetize the penis or scrotum, since a large proportion of their sensory nerve supply is through the ilio-inguinal and genitocrural nerves which take origin from the lumbar plexus. One must, therefore, either inject the roots of these nerves in addition to the epidural anesthesia or use local anesthesia for the penis and scrotum.

ROUTE OF EXPOSURE OF THE KIDNEY

Position of Patient.—In choosing the position for the patient in kidney operations it is important to obtain as large a space as possible for the operation. For lumbar extraperitoneal operations, the patient is placed upon the sound side, resting upon a large cushion or some form of mechanical elevator. The space through which operation is to be done may be enlarged by separating the ribs as widely as possible from the crest of the ilium—the so-called costo-iliac space. The accompanying illustration shows the patient in this position. As shown here, the lower thigh is flexed, as is also the leg, whereas the upper member is straight (Fig. 647). The two legs are held in this position by a strap around the table.

It is important that the chest should not be allowed to twist either forward or backward, and for this purpose, on our special table, it is held firmly between the two pads which are attached to the elongated shoulder-rests with which this table is provided. The position of these two pads can be changed horizontally by sliding the shoulder-rest up or down the table to the required position.

Skin Incision.—Before making the incision the operator should map out the bony and muscular landmarks as carefully as possible. The tips of the eleventh and twelfth ribs should be located. The anterior superior spine, the crest of the ilium, and the anterior edge of the erector spinæ are noted. The most satisfactory incision begins over the middle of the eleventh rib (Fig. 649, *a*) and passes downward behind the tip of the twelfth rib, almost parallel to the anterior body of the erector spinæ muscle for a short distance. It then curves forward, passes downward at a distance of about 1 inch from the crest of the ilium, and terminates about over the anteriorsuperior spine in large, muscular, or very fat individuals, and in those in whom a large kidney or difficult operation is expected. If the patient is thin or a less difficult operation is expected, the incision may be considerably shorter.

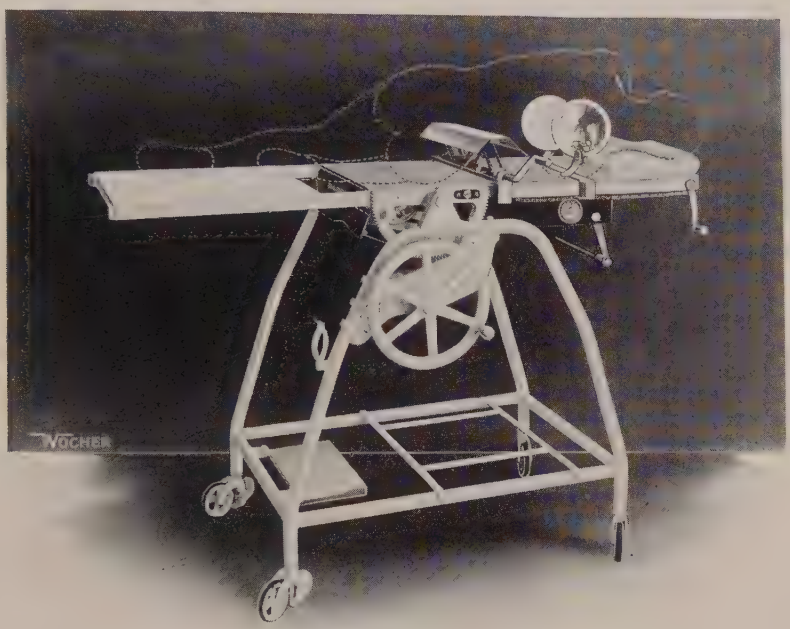


FIG. 647.—Young's table, with *x*-ray attachment removed, in horizontal position for operations upon the kidney. Patient is shown on right side with kidney elevator in position and chest and back pads holding the body vertical.

Abdominal Wall.—After dividing the subcutaneous fat and superficial fascia, the fascia covering the external oblique is reached. At this point it is well to stop, and, by means of a sponge, push back the fat on each side so as to obtain a fairly wide area of clean fascia. One then hunts for Petit's triangle, which is bounded posteriorly by the latissimus dorsi and anteriorly by the external oblique. It is recognized as a depressed area (Fig. 649), covered with fairly dense fascia. With the scalpel this is incised obliquely. Inserting the finger, it is usually possible, by blunt dissection, to open up the region approaching the kidney. Posteriorly one encounters the erector spinæ on introducing the finger. By blunt dissection the anterior muscles are elevated and the wound enlarged until two fingers may be inserted. An incision is then made through the external oblique and the wound is also enlarged by a vertical incision, as shown in Fig. 650, which gives the

anatomy at this stage of the operation. The lumbar fascia in the bottom of the wound is then punctured with forceps, and rapidly enlarged by blunt dissection (Fig. 651). This discloses a mass of pale fat of varying thickness. Posteriorly one sees the quadratus lumborum muscle and, running along it, the first lumbar nerve.

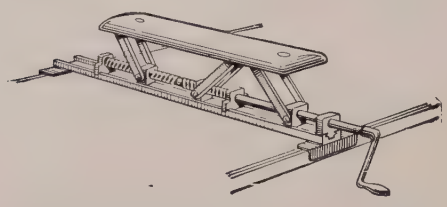


Fig. 648.—Young's body elevator for renal or abdominal operations. It is arranged to slide up and down the table and is operated by two reverse screws.

Sometimes the two branches of the iliohypogastric and the ilio-inguinal nerves are made out. As these nerves are very important, great care should be taken to avoid them, but as they lie in the posterior part of the wound, little difficulty is experienced in accomplishing this. In subsequent suturing their position should be noted and avoided.

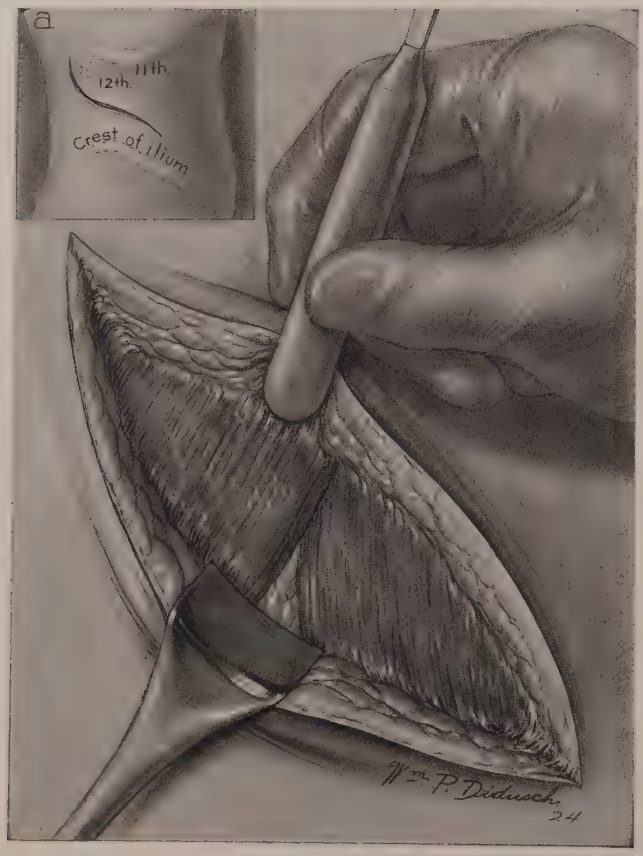


Fig. 649.—Extraperitoneal lumbar approach to kidney. Oblique curved incision (*a*) beginning above and behind point of twelfth rib and running downward and then forward parallel to crest of ilium, length depending on size of patient or extent of renal operation. Latissimus dorsi (above), external oblique (below), Petit's triangle between.

By blunt dissection and stretching, the space should be enlarged as much as possible. This will expose a large area of perirenal fat which is of orange-yellow color and varies in amount according to the individual. At this point the operator

FIG. 650.—Extraperitoneal lumbar approach to kidney. Division of external and internal oblique and transversalis after separation from fascia, behind, with fingers.

FIG. 651.—Operation to reach kidney through oblique muscle-cutting extraperitoneal incision; the external oblique, internal oblique, and latissimus dorsi muscles have been divided.

should quickly survey the situation to see what further enlargement of the wound may be necessary. Figure 652 shows a cross-section of the anatomy at this stage

of the operation. In thin women with wide pelves no further cutting may be necessary. In fat individuals and very muscular men, or if a difficult operation is ex-

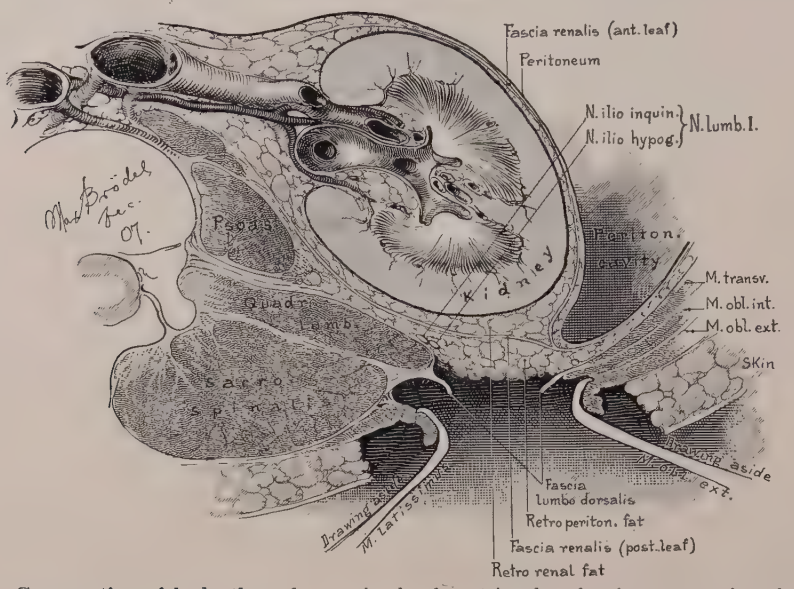


FIG. 652.—Cross-section of body through superior lumbar triangle, showing anatomic relations of structures met with in oblique lumbar incision for exposure of the kidney. Kelly-Burnam.

pected, the wound should be enlarged above and below so as to get the maximum exposure. By inserting the fingers beneath the abdominal muscles, one can push

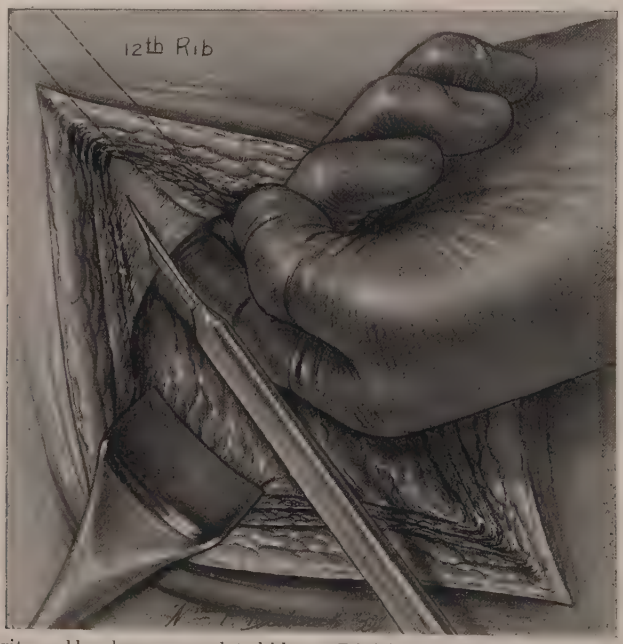


FIG. 653.—Extraperitoneal lumbar approach to kidney. Division of costovertebral ligament of twelfth rib.

away the peritoneum and then divide the abdominal muscles obliquely downward and forward parallel to the crest of the ilium as far as may be necessary.

Numerous blood-vessels are encountered, and should be carefully clamped and ligated. The important nerves, both anteriorly and posteriorly, should not be injured. Attention should then be given to the upper angle of the wound with the idea of getting as much exposure there as possible. The serratus muscles covering the ribs should be divided behind the tip of the twelfth rib, and the ligament of the last rib also divided. Before doing this, it is well to place the finger beneath the rib and its ligament, push the diaphragm and pleura upward, and divide the ligament at some distance from the rib (Fig. 653), so as not only to avoid injuring the pleura but also so as to be able to clamp any blood-vessels which may be encountered. At times transfixion sutures may be necessary to control the hemorrhage at this point.

FIG. 654.—Extraperitoneal lumbar approach to kidney. *a*, Clamp inserted through perirenal fascia and opened out, perirenal fat emerging. Large drawing shows separation of kidney from its fatty capsule within perirenal fascia.

By thus freeing the last rib considerably better exposure of the kidney is obtained. We have almost never found it necessary to excise the last rib, but many operators have employed this procedure. When this is determined upon, an incision is made along the outer surface of the rib, the periosteum scraped up, the rib enucleated from its bed, and cut off by bone forceps. Rib resection unquestionably enlarges the wound and makes difficult operations somewhat easier, but we prefer to enlarge the wound below or anteriorly through muscle incisions.

Having obtained a wide field of exposure the fat is broken through and pushed aside with gauze until the perirenal fascia is exposed as thoroughly as possible. It will be found to extend up toward the diaphragm; anteriorly it merges with the peritoneum, and forms a sac for the kidney and the perirenal fat; posteriorly it is confluent with the retroperitoneal fascia. At this point palpation

should be made to determine the location of the kidney. In some cases the kidney is found to be held fixed in high position, well up beneath the ribs. In other cases it may be movable and dropped far below its normal position, sometimes being at the brim of the pelvis, or even within the pelvis. Abdominal pressure may be necessary to push the kidney up to a point where it can be palpated.

Exposure of Kidney.—Having determined the position of the kidney, the next step is to open the perirenal fascia. This is best done with a curved clamp and one sees immediately beneath the lemon-yellow perirenal fat which is quite characteristic. Rapidly enlarging the wound, the kidney surrounded by its loose capsule of fat is seen. Attachments between the fat and the kidney are generally very loose, and easily strip away with little or no hemorrhage (Fig. 654). In some cases, however, the fat is adherent, and strips with difficulty. Where tuberculosis or tumor is present many authors advise that the perirenal fat be removed with the

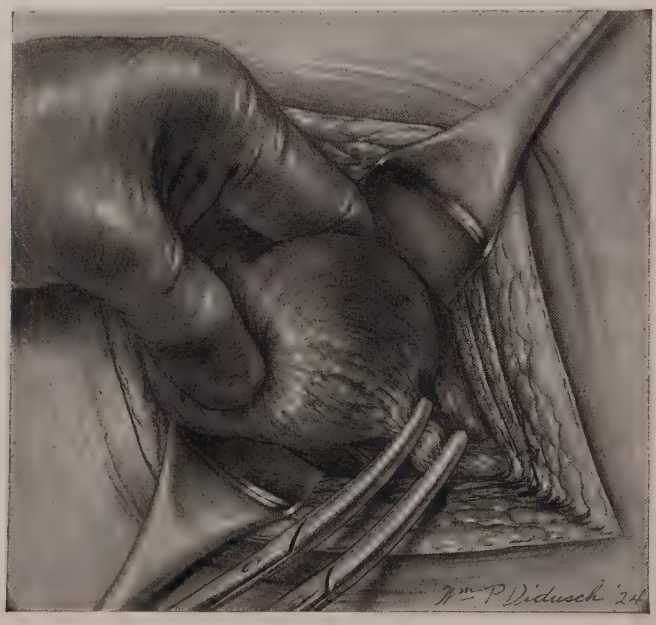


Fig 655.—Extraperitoneal lumbar approach to kidney. Clamping fatty vascular adhesions at lower pole of kidney preliminary to division and ligature.

kidney, but this is quite difficult and often impossible. On this account we have devised a transperitoneal technic for renal tumors in which the peritoneal covering and fat beneath it are removed with the kidney. It is described further on in this chapter. By blunt dissection the space between the kidney and the perirenal fat is opened up, exposing the anterior, external, and posterior surfaces of the kidney.

At the upper and lower poles stronger adhesions, and not infrequently blood-vessels, are encountered, so it is usually desirable to clamp, divide, and ligate in order to avoid hemorrhage (Fig. 655). At times serious bleeding is encountered by failure to ligate aberrant vessels. This is particularly true with the upper portion of the kidney, and great care should be taken in carrying out this part of the freeing operation. If a large blood-vessel is torn across, and escapes at this juncture, particularly if it is on the right side, the operator should be careful not to

apply clamps recklessly in the depths of the wound because it is quite possible on the right side to injure seriously the small intestine and pancreas, or vessels supplying them, and to cause serious necrosis, etc. We have reported cases of fat necrosis and one death following injury of the pancreas in kidney operations on the right side[1] (Figs. 656–658). The peritoneum may be torn, which is seldom serious if immediately repaired. As peritonitis may occur in infected cases, every care should be taken to avoid this accident.

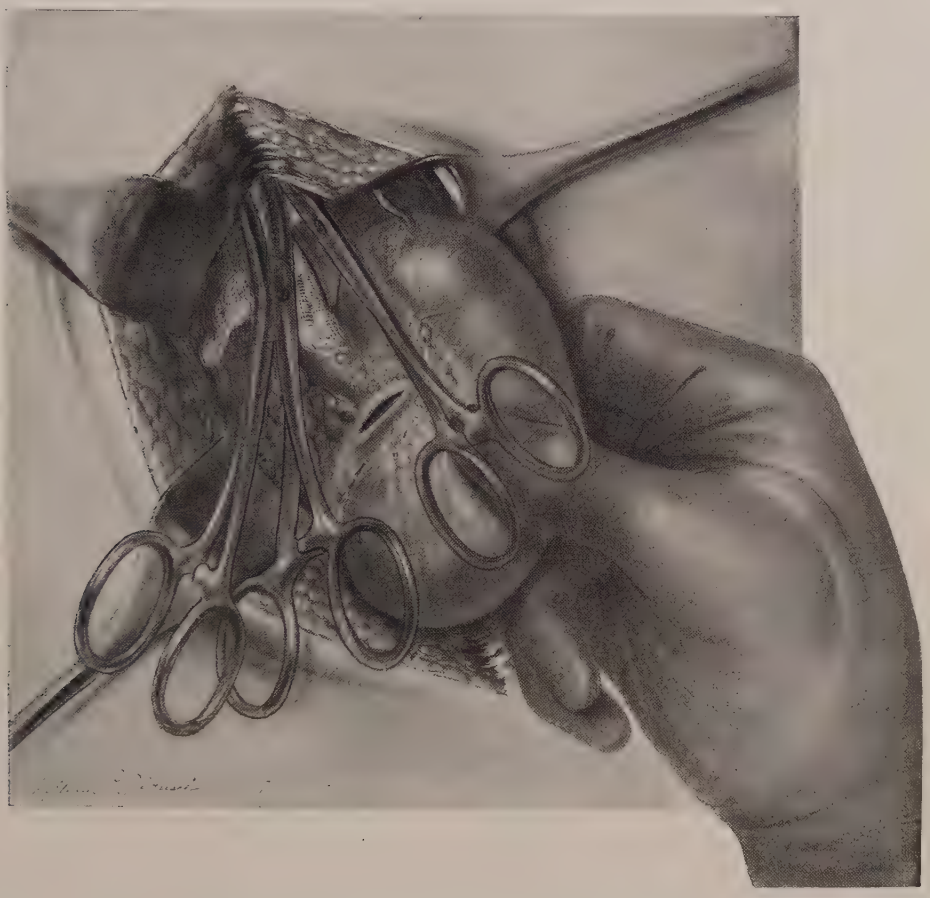


FIG. 656.—Injury of pancreas while attempting to arrest hemorrhage caused by aberrant artery which escaped ligature in a pyelotomy case. B. U. I. 3565.

Having thus ligated the vessels at the upper and lower poles, and exposing the anterior, external, and posterior aspects of the kidney, it is usually well at this point to try to find the *ureter*. The lower end of the wound should be freed of fat as deeply as possible, and the peritoneum elevated with deep retractors. It is rarely possible to see the ureter at once, and it should be sought for by the operator's finger and thumb. It must be remembered that the ureter is more closely attached to the peritoneum than to the posterior structures, and that, with the peritoneum thus elevated, it will usually be found in front of the hand in the depth of the wound, and it can usually be recognized by palpation as being a fairly firm

[1] Young and Colston, J. A. C.: Journal of Urology, 1917, i, 179–191.

tube running upward to the kidney, and downward to the brim of the pelvis. Lines of lymphatics and blood-vessels may be encountered (spermatics) and may be mistaken for the ureter. When the ureter is found it should be separated, and a markedly curved (goose-neck) clamp passed around it for the purpose of drawing tape around it (Fig. 672).

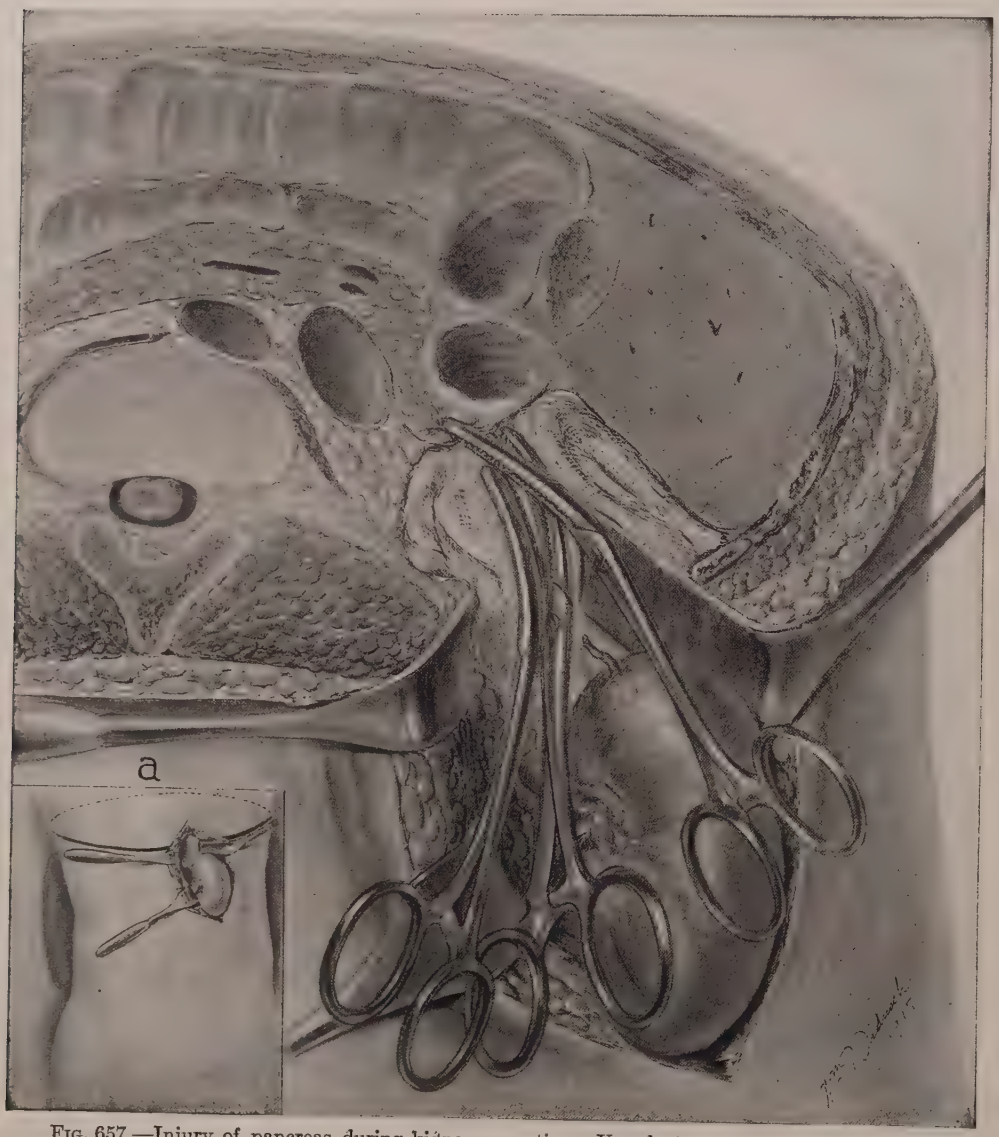


FIG. 657.—Injury of pancreas during kidney operation. Vessel at upper pole of kidney, deeper end of which escaped ligature, is shown. Clamps and gauze introduced in effort to stop hemorrhage, shown in schematic cross-section, in which injury of pancreas is depicted. B. U. I. 3565.

If the ureter cannot be found in this way, it may be found where it joins the pelvis.

Having thus freed the kidney everywhere except at the vascular *pedicle*, and with the ureter under inspection, the operator is in a position to make a careful examination and determine what further steps are to be carried out. If he desires

to explore the pelvis, it is usually only necessary to pull the kidney forward toward the median line so as to expose to posterior surface and put the ureter on tension, to locate the blood-vessels of the pedicle, and the position of the pelvis below them. In most instances a small layer of fat covered by a delicate fascia covers the posterior surface of the pelvis. This fat should be divided longitudinally in the direction of the ureter and pushed aside with a Küttner gauze dissector. Such exposure of the pelvis is necessary in pyelotomy operations, but the presence of a stone greatly facilitates the opening of the pelvis.

The vascular pedicle varies within wide limitations both as to number and character of blood-vessels, the points at which they enter the kidney, their length and elasticity. There is also great variation in the amount of fat and fibrous tissue which surrounds the vessels. In some cases the pedicle is so long and elastic that

Fig. 658.—Injury of pancreas during kidney operation. Anatomic transverse section which shows close relation of pancreas to kidney and duodenum.

no difficulty is experienced in drawing the kidney out upon the skin surface. This is particularly true in women with kidneys which are more apt to be movable than in men. In many cases the outer border of the kidney only can be drawn into the skin wound and pyelotomy operations have to be carried out at some depth.

In cases where the pedicle is surrounded by inflammatory or fibrous tissue (sometimes of great thickness) it may be impossible to draw the kidney up more than a slight degree. In such cases the operative procedures upon the vascular pedicle may be very difficult. As a rule, however, the kidney can be exposed in its entirety without difficulty.

Drainage and Closure.—The special operations which may be required are described elsewhere. After one of these has been carried out the closure of the wound and question of drainage is next to be considered. Where good hemostasis has been secured, the renal contents have not been spilled, and the wound kept

free from infection, the operator may be justified in closing the wound without drainage. As a rule, however, there is sufficient oozing and possibility of infection to warrant a small rubber drainage-tube at the upper angle of the wound. If the oozing is considerable, gauze packs may be used, but they should be avoided if possible.

It is not necessary to try to close up or reduce the extraperitoneal space. Abdominal pressure with the patient on his back is sufficient to take care of that. If the abdominal muscles have been divided, as above described, they should be brought together again as carefully as possible. For this purpose various sutures have been employed. Our preference is for a continuous heavy chromic catgut suture which begins at the lower angle of the wound and approximates the posterior fascia and the deeper layer of muscles until the upper angle of the wound

Fig. 659.—Oblique lumbar extraperitoneal operation to expose kidney. First layer of sutures approximating internal oblique and transversalis muscles.

or the site of drainage at that point is reached (Fig. 659). The line of sutures then turns downward and includes the external oblique and its fascia in a through-and-through continuous suture which is tied, at the lower angle of the wound, to the initial suture left long for the purpose. In applying the aforesaid suture care should not only be taken to bring the strong muscular structures together, but also the fascia of the external oblique into good apposition. If there is much subcutaneous fat a running suture of plain catgut, to bring this together and to avoid dead spaces, may be advisable.

The skin may be closed in various ways. At present we prefer metal clips placed about 1 cm. apart, so as to produce a slightly everted, well approximated skin wound (Fig. 660). In important cases where the wound is large and hernia is feared, stay sutures of silver wire passed through the muscles, fascia, and skin, and

emerging about 2 cm. from the edge of the wound, above and below, may be employed, but we rarely have found them necessary except in cases of renal tuberculosis, which are prone to break down.

Where the wound is infected by urine, or pus escapes into the wound it should be mopped out with gauze followed by salt solution and non-irritating antiseptic solutions. Stay-sutures are very important.

FIG. 660.—Oblique lumbar muscle-cutting extraperitoneal operation for exposure of kidney. External oblique and latissimus dorsi are shown approximated with catgut suture, drainage at upper angle; skin approximated with clips.

Tube drainage should be provided at the upper end of the wound. We almost never drain at the lower angle of the wound unless the incision has been carried far downward in following the ureter, as in nephro-ureterectomy for tuberculosis.

PYELOTOMY

The principal value of pyelotomy is to remove stones from the pelvis or calices of the kidney. In rare instances, the pyelotomy may be done in connection with some plastic upon the ureteropelvic juncture.

As a rule, it is possible to determine beforehand what calculus cases can probably be attacked successfully by pyelotomy. Briefly stated, these are cases in which the stone is confined to the pelvis of the kidney, is not of too branching a character and is not held by constrictions within the major or minor calices of the kidney. For very large stones separated from the pelvis by narrow passages or embedded in the substance of the kidney the operation is manifestly unsuitable. Before operation one should find out the condition of the other kidney (supposedly sound), but should also determine, as accurately as possible, whether the kidney which contains the calculus is sufficiently valuable to be saved. It is generally possible by means of ureteral catheterization and functional tests to determine this before operation, but where the ureter is blocked by the stone it may be neces-

sary to wait until operation to decide whether to carry out nephrectomy or to remove the stone and trust to the restoration of the kidney.

Having determined that it is not advisable to remove the kidney, one must determine whether the stone can be removed or not through a pyelotomy incision. After freeing the ureter and exposing the posterior surface of the pelvis, palpation is made to determine whether the stone can be felt in the lower portion of the pelvis. If so, it is comparatively easy to push back the fat and prepare the pelvis for an incision to remove the stone (Fig. 661, *a*). If the stone is high up, it is sometimes possible to push it down into the lower portion of the pelvis, but not infrequently it may be necessary to open the pelvis at a point where the stone is not

Fig. 661.—Pyelolithotomy. Removal of calculus from pelvis of kidney: *a*, Kuttner dissector (gauze) used to expose pelvis; *b*, ureter held up with tape; pelvis incised over stone; *c*, final closure with continuous chromic catgut; *d*, incision closed transversely to widen pelvis. Usually this is unnecessary and longitudinal closure is carred out.

immediately beneath the line of incision. The incision should be made above the ureteropelvic juncture (Fig. 661, *b*). If a definite stricture is found at the ureteropelvic juncture, the incision may be continued downward so as to include this region and a portion of the ureter. By means of a transverse closure (Heinicke) at the end of the procedure (Fig. 661, *d*) the ureteral stricture is thus relieved and the lumen greatly dilated. If the stone is in the lower portion of the pelvis, the incision is made long enough to extract it. If the stone is tightly held by the mucous membrane adhering to its roughened surface, by means of a delicate blunt dissector or gentle traction with a ureteral stone forceps the stone can usually be withdrawn intact, though it may be necessary to enlarge the pelvic incision. The

operator should avoid carrying the pelvic wound up to the hilus of the kidney as bleeding is apt to be encountered at that point and may be difficult to arrest should the kidney be injured. Where the pelvis is intrarenal, it may be necessary to make the incision in the ureter and insert the forceps until the stone is caught. This is applicable only for small stones. Where one stone is branched it may be possible by fracture of the calculus to withdraw it in two or three pieces, but, as a rule, such stones, particularly if large, are not suitable for a pyelotomy. Where the stone is situated in the upper portion of the pelvis or in one of the calices it may be difficult to find and a careful search with stone forceps aided by palpation from without may be necessary to remove it. Occasionally needling through the substance of the kidney while inspecting the *x*-ray plate may make it possible to find the stone which is difficult to detect. Before considering the operation complete a very thorough sounding with probe or stone forceps should be made of every calix that can be reached, and the stones removed should be compared with the shadows upon the *x*-ray plate so as to be sure that every fragment has been removed. The use of the *x*-ray during operation has been recommended by several authors and may be of very great importance in certain cases.

Braasch and Carman[1] employ a portable apparatus with an *x*-ray tube covered with a sterile towel and pushed up to the kidney so that the operator can inspect the interior of the kidney with a fluoroscope. It is not necessary to darken the room for this purpose, but the *x*-ray operator should keep his eyes within the dark fluoroscopic cone for several minutes before viewing the kidney. In several instances fragments which had been undetected by the operator have been discovered by this method. Quinby and others have made use of an *x*-ray film, the exposure being taken upon the table by placing the film immediately beneath the kidney and the operator waiting until it is developed and examined.

The frequent recurrence of calculus after pyelotomy and nephrotomy makes it almost imperative that some such methods be employed in certain cases, particularly if fragments shown on the previous *x*-ray plate are not accounted for in the specimens removed. A wax-tipped probe or bougie may be used to make sure no stone remains.

After the kidney pelvis has been completely emptied of calculi, it should be washed out with some mild antiseptic (1:1000 meroxyl) so as to remove stone fragments, exudate, or blood-clots. Before closing the wound a catheter or bougie (preferably spiral metal) should be passed down the ureter with the object of detecting the presence of calculi, strictures, etc. If obstruction is met with, wax-tipped bougies may be used to determine whether a calculus is present. It may be wise to follow the ureter down between thumb and forefinger, freeing it from constricting adhesions until the point of obstruction is reached, when the calculus, if present, can usually be felt without difficulty. In some cases constrictions due to inflammatory adhesions with neighboring organs are encountered, and these may then be broken up by blunt dissection. In the female these are apt to be in the region of the broad ligament, and in the male near the base of the seminal vesicles (we[2] have reported one such case).

After determining that there is no ureteral stricture or calculus and being satis-

[1] Journal of the American Medical Association, 1919, lxxiii, 1751, 1752.

[2] Young: Ann. d. Mal. d. Org. Gén. Urin., 1904, xxii, 1. Mark, E. G.: Journal of Urology, 1922, viii, 89–98.

fied that the calyces and kidney pelvis have been completely freed from calculi and blood-clots, closure of the pelvic wound is begun. Ordinarily approximation of the two sides by means of a continuous, fine, chromic catgut suture, which includes all the layers, is sufficient. If the ureteropelvic juncture is strictured, the wound may be closed transversely and thus a considerably enlarged lumen obtained (Fig. 661, *d*). Where the ureteropelvic juncture is not at the bottom of the pelvis some form of plastic may be carried out to secure dependent drainage. As a rule, simple closure is all that is necessary and plastics are rarely desirable. Some surgeons attempt to bring the fat together over the pelvic wound, but this is rarely satisfactory and, we believe, hardly necessary.

If the surgeon finds it impossible to get accurate approximation or completely to close the pelvic wound, it may be left open with impunity. Statistics show that it is extremely rare for a ureteral fistula to persist and not infrequently *per primam* healing, without leakage, is obtained. It is well, however, to provide deep tube drainage through the upper angle of the wound. Mayo particularly advises against any form of gauze drainage in pelvic or ureteral wounds. When the kidney is replaced it is not necessary to use any fixation stitches, but simply to put it back in as normal a position as possible. The external wound is closed as above described.

NEPHROTOMY AND NEPHROSTOMY

Nephrotomy is usually done for calculus, but occasionally it has been employed in renal hemorrhage (essential hematuria), and for certain rare conditions within the renal pelvis which cannot be reached through pyelotomy.

Nephrolithotomy is so varied in its nature and extent that it is impossible to describe any standard procedure. Much depends upon the location, size, character and multiplicity of the stones, their relation to each other, if multiple, and the configuration of the major and minor calyces, pelvis, and ureter.

Where there is a single calculus which is palpable, immediately beneath the cortex, it may suffice to open the cortex with a blunt forceps, dilate the wound sufficiently to grasp the calculus, and remove it. Careful exploration must then be done to see that no fragments are left behind nor other stones present. The operator should compare the stones removed with the *x*-ray plate. By means of forceps, probes, or the finger the pelvis and calyces should be as thoroughly explored as possible and thus the interior freed of sand and clots before closing the cortical wound with mattress-sutures of catgut. The *x*-ray should be employed to make sure that no stone or fragment is left behind.

Where the stone is surrounded by much kidney substance which has been destroyed by pressure or suppuration, the question of excising the diseased renal tissue along with the stone must be considered. We have published elsewhere a case in which this was carried out and a further discussion of this subject will be found on page 272.[1]

Where there is no indication on the surface of the kidney as to where the calculus lies, and particularly if it is deep-seated, most careful studies must be made before determining just what incisions may be necessary to properly expose the kidney for removal of the stone and thorough exploration of the cavities. If the plain *x*-ray and the pyelogram make the location of the stone very definite, one may safely attempt to go down upon it with a blunt forceps, and, if it is detected,

[1] Young: Surgery, Gynecology, and Obstetrics, 1924, xxxiii, 107–111.

to enlarge the wound and remove the stone. Here Burns' needling method is of much help. If incisions are necessary, these should be made either along Broedel's line (just posterior to the convex border) or radially in the direction of the hilus, so as to avoid division of the arterial branches. Cullen, Derge, and Broedel have shown that this can be best done by means of a silver wire which has been passed through the kidney substance with a long curved needle and is then drawn out by a to-and-fro motion, cutting the intervening kidney substance as it comes out.

If considerable hemorrhage is encountered, this may be arrested by compressing the vascular pedicle of the kidney between the thumb and finger; either the operator or an assistant may do this while the operation is in progress. Perhaps a more satis-

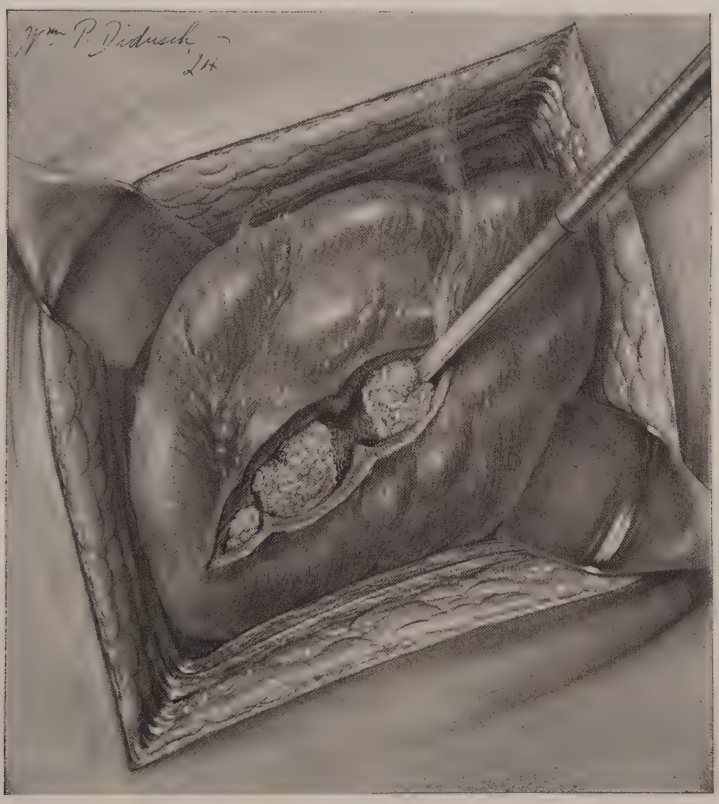


FIG. 662.—Nephrolithotomy. Opening of cortex of kidney with cold or hot cautery, with hope of preventing hemorrhage. Deep septa are usually found between branches of calculus.

factory procedure, particularly where the vascular pedicle has been thoroughly freed, is to encircle it with a fairly strong elastic rubber tube and thus cut off the blood supply. Kümmell has recommended a "feather-like" pedicle clamp, but instrumental traumatism is to be avoided if possible.

It is well to reiterate that before closing the kidney one must be sure that every fragment has been removed and good drainage secured. When calculi cannot be detected or lie within the more remote portions of the kidney pelvis and calyces, so that they cannot be removed through a single small incision, it may be necessary to open the kidney widely and thus explore every portion of the pelvis and its ramifications. For this purpose for many years a so-called anatomic

incision was made. After compressing the renal vessels, the kidney was completely opened through a wide incision along the cortex, as at autopsy, so that every calyx could be explored. Such a procedure has much to condemn it. In the first place, the hemorrhage is considerable and difficult to control, requiring numerous deep mattress-sutures, which cause marked necrosis and atrophy of the kidney so treated. Fatal secondary hemorrhages have been not uncommon. The introduction of the silver wire method of Cullen and Derge has been of some assistance in avoiding hemorrhage, but it is very difficult to carry this out exactly in the nonvascular zone and considerable hemorrhage is almost always encountered. Nevertheless, this procedure may be necessary in order to remove all calculi present.

When a stone is of the multiple-branched or stag-horn variety, projecting from the pelvis into several calyces and sometimes completely filling all the calyces, very wide opening of the kidney is necessary. In such cases one frequently finds deep, thick, fibrous septa between the branches of the calculus, and on division of these blood may flow freely. We have attempted to clamp and ligate (or transfix) these separately, and again we have divided them with a cautery (Fig. 662). If the other kidney is healthy, nephrectomy may often be the operation of choice, even though the stone-bearing kidney may have fairly good function, as stones are apt to recur in the deep sacculations.

In the closure of a kidney which has been subjected to a wide opening it is necessary to have two or three layers of deep, through-and-through mattress-sutures of heavy catgut tied on the outside of the kidney to control the bleeding. The cortical wound should be approximated by tying the long ends of the sutures around the convex border, as shown in Fig. 664, reinforced by interrupted stitches. After the suture is complete the pressure upon the pedicle may be released and additional mattress-sutures inserted to control any marked bleeding that may occur. After a time the kidney swells and internal pressure is usually sufficient to stop the bleeding, so that one should avoid placing too many and too tightly drawn sutures. Deep drainage is usually to be employed and the wound closed as described above.

Jianu[1] has recommended placing mattress-sutures from cortex to pelvis in the same plane as the cut surface of the kidney. The method is ingenious and may be valuable in some cases.

RESECTION OF THE KIDNEY

This operation has been carried out only in rare instances. It is quite appropriate for solitary renal cysts. These usually occur at one pole of the kidney, where they form thin-walled sacs. These can usually be dissected free from the kidney without difficulty. It is well to remove completely the mucous lining of the cyst where it is attached to the kidney substance, and in so doing it may be necessary to cut into the kidney tissue. In such cases hemorrhage is encountered, but by approximating the cut surfaces of the kidney with through-and-through mattress-sutures of catgut the defect is closed and the hemorrhage controlled.

Interesting cases of this type have been reported by Brin[2] and Binney.[3] In-

[1] Surgery, Gynecology, and Obstetrics, 1924, xxxviii, 652–656.
[2] Encyclopædie Française d'Urologie, 1914, iii, 1–74 (Lit).
[3] Cabot's Modern Urology, 1924, ii, 696–700.

teresting discussions as to the operative technic are found in recent papers by Kretschmer[1] and by Harpster.[2]

Resection of the kidney has been carried out in tuberculosis by several surgeons, but the results obtained are certainly far from satisfactory and in many cases deplorable, so that the consensus of opinion is that this procedure should practically never be done in tuberculosis—nephrectomy being generally imperative.

FIG. 663.—Resection of kidney for abscess and stone of upper pole after ligation of vessels supplying this portion. B. U. I. 11,504.

Resection of the kidney may be carried out occasionally in *nephrolithiasis.* We[3] reported one such case in 1917. This was the first case to be reported in which before operation it was deliberately determined to carry out the resection of the upper diseased half of the kidney, the *x*-rays and ureter catheter having shown that the lower pelvis and kidney half were healthy. Since then additional cases have

[1] Journal of Urology, 1920, iv, 567–583 (Lit.).
[2] Ibid., 1924, xi, 157–175 (Lit.).
[3] Young and Davis, E. G.: Journal of Urology, 1917, i, 17–32.

been reported in the literature, including other cases in which the condition was discovered accidentally at operation. We have recently reported 1 case in which a single kidney contained a stone in a markedly dilated, diseased upper portion. In this case a resection of the upper half of the kidney was done and the wound closed satisfactorily. Three other cases were mentioned in this article in which we proposed resection for calculi in much dilated or dependent and poorly draining portions of the kidney pelvis, which contain calculi. We have on hand now in

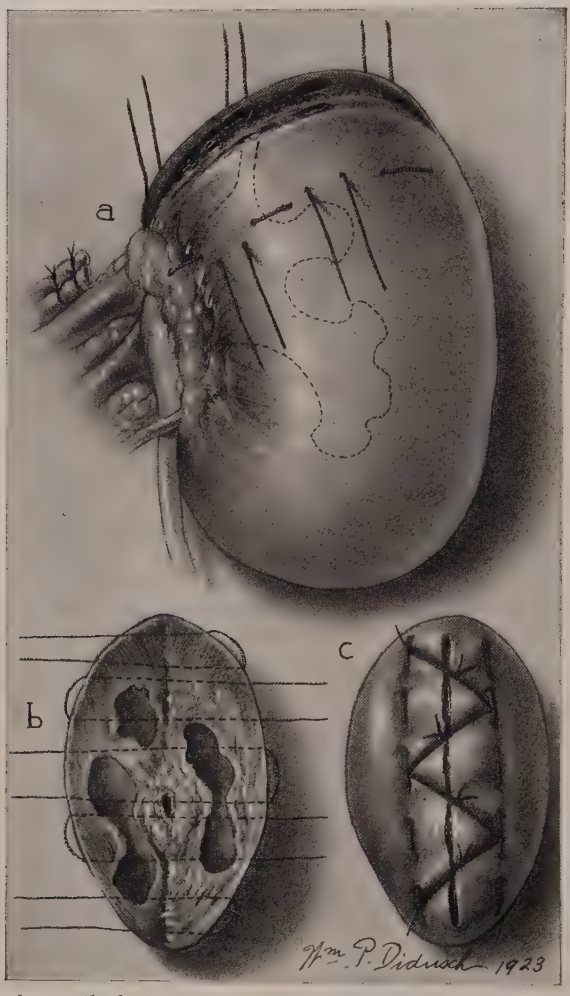


Fig. 664.—*a*, Showing method of suturing to control hemorrhage and approximate cut surfaces after V-shaped excision. *b*, Placing mattress-sutures, alternately from opposite sides; *c*, final closure, alternate sutures tied to complete closure of surface. B. U. I., 11,504.

the literature a sufficient number of cases to show the value of resection in certain cases of calculus.

The operation is carried out as follows: The vessels supplying the portion to be excised are ligated and divided (Fig. 663). An elastic ligature is placed around the remaining vessels of the pedicle and the hemorrhage controlled. Incision is made at the junction between the healthy kidney and the diseased portion, which is completely excised.

All mucous membrane at the bottom of the wound is removed, the kidney wound is deepened so as to form a V, the edges of which can be brought together by deep

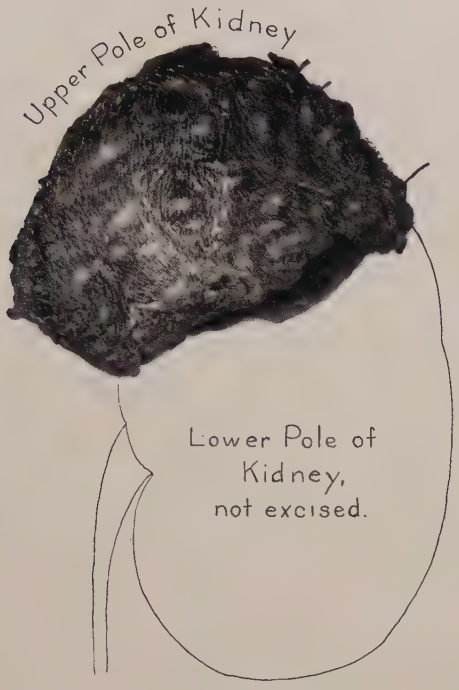


FIG. 665.—Photograph of upper third of kidney removed at operation. Rest of kidney indicated in outline. B. U. I. 11,504.

mattress-sutures of catgut so as to approximate kidney substance and capsule and thus close the wound completely (Fig. 664). The hemorrhage is controlled by deep sutures through the kidney substance. As stated in our article,[1] this oper-

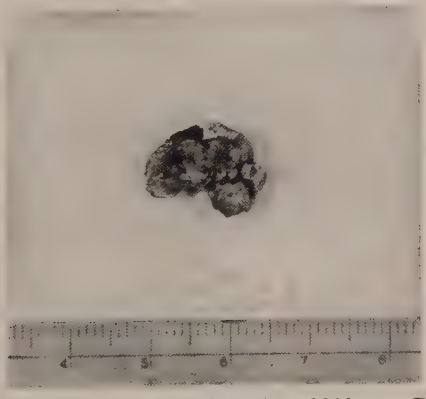


FIG. 666.—Calculus found in resected portion of kidney. B. U. I. 11,504.

ation would seem to be applicable where the kidney substance was almost completely destroyed in the region of a calculus or calculous pyonephrosis, so that

[1] Young: Surgery, Gynecology, and Obstetrics, 1924, xxxviii, 107–111.

all hope of useful regeneration was past. The danger of recurrence of calculus in such a sacculated portion of the kidney is thus avoided. Particularly would it seem to be applicable when such conditions exist at the lower pole of the kidney where the drainage would be most unsatisfactory. It would seem that such a procedure would do away with the recurrence of calculi so often seen after neph-

FIG. 667.—Resection of upper half of double kidney and bifid pelvis containing stone. The kidney has been freed and drawn out of the wound. Note line of demarcation between two halves of kidney. B. U. I. 5007.

rolithotomy, and for this reason we wish to propose its frequent use in cases where nephrotomy is required and the above-mentioned conditions exist.

When a double kidney is present (Fig. 667) and the diseased portion is in bad condition resection should be carried out for the reasons advanced above. In our case, which is apparently the first in which this operation of heminephrectomy was deliberately planned beforehand and carried out in a case of double kidney and bifid pelvis,[1] the incision was made at the point of junction of the two halves

[1] Young and Davis, E. G.: Journal of Urology, 1917, i, 17–57.

of the kidney. This location was shown on the surface of the kidney by a groove around the cortex (Fig. 667). When incision was made with a scalpel (Fig. 668)

Fig. 668.—Resection of upper half of double kidney and pelvis for stone and infection. Transverse incision of kidney above level of furrow showing point of junction of two halves. B. U. I. 5007.

little bleeding occurred, and it was shown that the blood supplies of the two halves of the kidney were separate and distinct (Fig. 671). The operation can, there-

fore, be carried out in these cases with little danger of bleeding, but the cut surfaces of the remaining kidney should be brought together with mattress-sutures,

FIG. 669.—Resection of the kidney. Third stage of operation. The diseased segment has been removed, its ureter ligated, and hemorrhage from the normal portion controlled by mattress-sutures.

as above described (Figs. 664, 669). The specimens removed are shown in Figs. 665, 666, 670.

It is remarkable that so few cases of resection of the kidney have been done,

but we feel justified in predicting for the operation much more usage in the future, particularly in cases of calculus with extensive destruction of kidney substance.

Fig. 670.—Large branching calculus removed with upper half of double kidney. B. U. I. 5007.

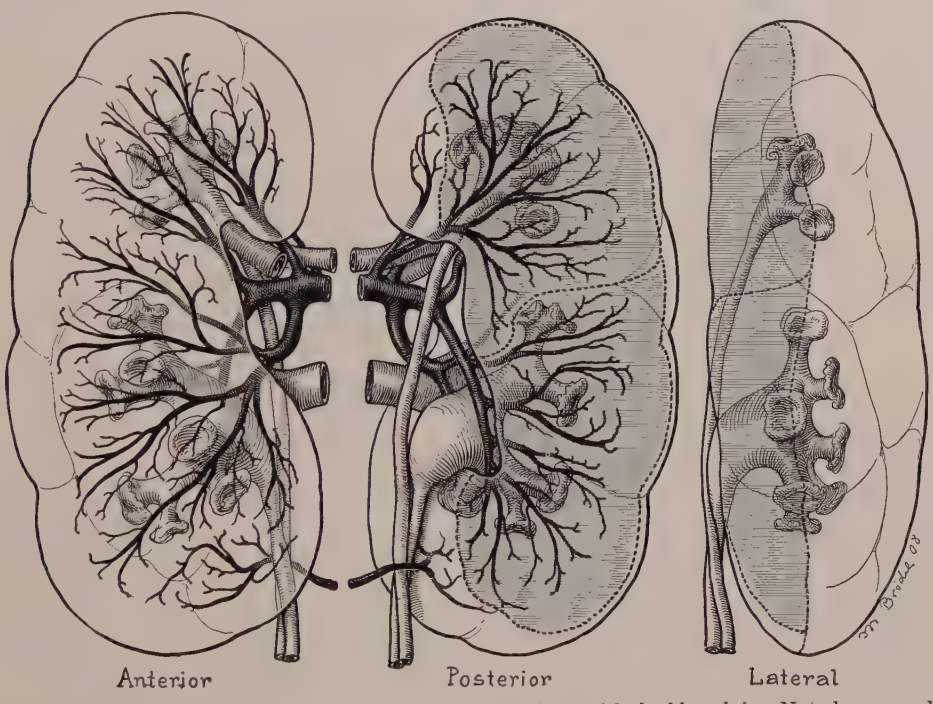


Fig. 671.—Three views of corrosion preparation of kidney with double pelvis. Note how complex the arterial circulation has become. There are now two posterior arteries, each skirting the renal pelvis as in a normal case. The lower posterior artery runs obliquely backward between the two pelves. The shaded areas represent the territory of the posterior vascularization. Kelly-Burnam.

We have recently carried out resection of the kidney for stone, by the technic described above, in 3 more cases.

NEPHRECTOMY (LUMBAR)

The indications for nephrectomy are destruction of the kidney too complete to hope for regeneration, especially with chronic infection present; tuberculosis of the kidney; tumors of the kidney; calculi too extensive for removal or certain of recurrence, severe traumatism, etc.

In simple cases nephrectomy is not a difficult procedure. The kidney is exposed, as above described, and the vascular adhesions clamped, divided, and ligated. The ureter is freed and brought up into the wound on a tape or clamp, and injected with pure carbolic to cauterize the interior (Fig. 672, *a*). It is then crushed with clamps, and ligated doubly in the tracks of the clamps and divided. The vascular pedicle is examined, separated from adhesions as carefully as possible, and plans

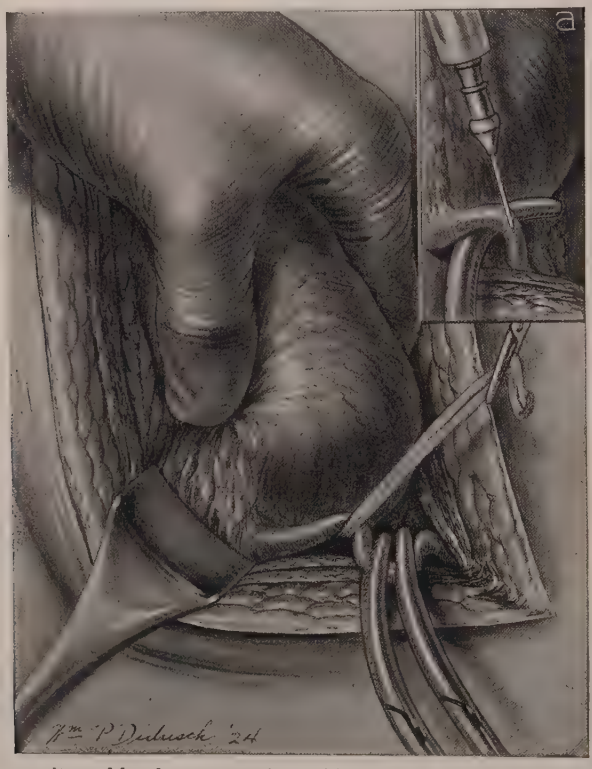


Fig. 672.—Extraperitoneal lumbar approach to kidney. Nephrectomy. Exposure of ureter which is elevated on a curved clamp. *a*, Injection of pure carbolic by hypodermic syringe preliminary to clamping, division and ligature.

laid for removal of the kidney. At this point a thorough study of the blood-vessels in the pedicle should be made, their relative position and size being determined.

By careful blunt dissection, using a Küttner dissector, the fat and adjacent tissues can be pushed aside (Fig. 661, *a*), so as to make it possible to isolate the vessels and clamp them separately. We usually try to pass a blunt dissector or a curved clamp between the vessels and then apply to the isolated portion three large clamps and divide between the most external and the middle clamp (Fig. 673, *b*). Ligatures are then applied at once, the first being beneath the deepest clamp, which is loosened as the ligature is drawn taut and removed before the knot is tied. This method has the great advantage that the ligature slips into the de-

pression produced by the clamp. The second clamp is removed after placing a ligature in the same way, thus leaving the stump of the pedicle doubly ligated. It is usually well to ligate the distal stump, next to the kidney, before the clamps on the stump are ligated. The operator then proceeds to isolate and triply clamp another portion of the pedicle and then to divide and ligate as above described.

In most of our cases, three such isolated groups of ligatures are placed, and one feels perfectly confident that no hemorrhage will occur. It has, in our opinion, a great advantage over the method of ligating the entire pedicle in one mass as is commonly employed. We are also opposed to the method of suturing the pedicle

FIG. 673.—Extraperitoneal lumbar approach to kidney. Nephrectomy. The ureter has been ligated, vessels of pedicle are then isolated, and clamped separately. *a*, Preliminary separation of vein; *b*, triple clamping of vein; *c*, triple ligation of vein which has been divided between middle and outer clamps. Outer end ligated singly first, deeper end ligated doubly, the first ligature placed beneath deepest clamp which is removed before ligature is drawn tight; *d*, ligation of other vessels.

around a clamp which is in common usage, though it may be necessary in rare instances. Where the pedicle is surrounded by a large amount of inflammatory, fibrous, or sclerotic tissue, the isolation of the vessels in the pedicle may be practically impossible, but even then one can usually divide the pedicular mass into two or three portions and clamp them separately as above described. Where this is impossible, one may be forced to clamp the entire pedicle in one piece. Here again the three-clamp method should be employed and is almost always applicable. By using heavy clamps and crushing the tissues there is little danger of the suture slipping, if the above technic has been strictly adhered to. It must be remembered, however,

that the deeper clamp must be loosened as the ligature is tightened and removed before the knot is tied. If this is successfully carried out, sutures are not necessary. In their use one is never certain that they may not penetrate blood-vessels deeper down. We have seen 1 case in which the vena cava was penetrated with such sutures with subsequently fatal results.

In rare instances, with very thick, fibrous, adherent pedicles after successfully placing large clamps and removing the kidney, the operator may feel that it is next to impossible to place ligatures or sutures successfully around the deep-lying, thick, short pedicle. Fearing that hemorrhage would result from such a course when the clamps are removed, he is greatly tempted to leave the clamps in place for several days before removing them. Numerous reports in the literature recommend this procedure as being perfectly safe, and one series of 53 cases with only one death, in which this method was employed, has been reported. We followed the advice of this author in a case in which, after removing an extremely large renal tumor—the broad pedicle of which had been caught by heavy clamps—we thought it impossible to place ligatures satisfactorily. We, therefore, left three or four clamps in place and removed them four days after operation. We are sorry to report that the patient bled to death within five minutes, and autopsy showed that the renal vein, which was about $\frac{1}{2}$ inch in diameter and extremely thin, had not been sufficiently crushed by the clamps to afford opportunity for cicatrization. Since this occurrence, about eighteen years ago, we have made it an invariable rule to apply ligatures and to leave no clamps in place for subsequent removal. This has demonstrated to us the fact that if the operator persists, satisfactory ligatures or sutures can always be placed, which is demonstrated by the fact that we have had 111 consecutive nephrectomies for tuberculosis without a death.

Nephrectomy With Fatty Capsule (Extracapsular).—In cases of tuberculosis and particularly in malignant diseases, frequent advice is found in the literature to remove the fatty capsule with the tumor. This is often quite difficult to do and, in fact, is rarely accomplished in lumbar extraperitoneal nephrectomy. Perhaps if very great care is taken to stay without the fatty capsule it may be possible to carry the line of blunt dissection between the fatty capsule and the outer plane of fascia. In the cases in which we attempted this, we found on reaching the vascular pedicle that it was necessary to go through a layer of fat before the vessels could be exposed. In some cases this is not difficult. If, however, there is much fibrous infiltration in the fat it may make the exposure of the pedicle very much more difficult than when the enucleation is carried out between the fatty capsule and the kidney capsule proper. When the fatty capsule is removed with the kidney it is sometimes possible to remove at the same time the adrenal, and in tuberculosis and tumor this may be advisable, in very rare instances.

In tumor cases the transperitoneal route is far preferable, as in such the fatty capsule can be removed with the peritoneum covering it without much difficulty and far more satisfactorily than through the lumbar route, as will be described later on.

Intracapsular Nephrectomy.—In some cases the fatty capsule and capsula propria of the kidney are replaced by an inflammatory fibroid mass which is so densely adherent to the surrounding structures that it is extremely difficult to remove it with the kidney. In such cases an intracapsular nephrectomy may be carried out with far greater ease. In this procedure, after opening the capsule,

the kidney is enucleated by blunt dissection from within it until the pedicle is reached. At this point the operator will find the pedicle surrounded, not only by its fibrofatty tissues, but by the cuff of fibroid capsule which has been pushed back, as the kidney is drawn outward. In some cases it may be possible to draw the vessels of the pedicle out and isolate, clamp, and ligate them successfully, but in many cases it is necessary to make a circumcision through the fibrous capsule, which has been pushed backward, in order to expose the pedicle for ligation. Al-

Fig. 674.—Nephro-ureterectomy through extraperitoneal incision, prolongation of original incision to expose kidney (*a*).

though this method is not ideal and leaves behind a large mass of inflammatory fibroid tissue, it is sometimes the only method which can be successfully employed in such cases.

Nephro-ureterectomy.—This may be desirable in certain cases of tuberculosis and also of tumor, in which the ureter is involved. The ureter can be followed for a considerable distance without prolonging the incision made for nephrectomy. Should it be necessary to follow the ureter below the brim of the pelvis a long abdominal incision may be imperative, but through this it is possible to follow the

ureter almost to the bladder, to excise it completely, and ligate the distal stump (Fig. 674). Some writers have strongly advised two incisions in carrying out nephro-ureterectomy, the lumbar incision being used for the kidney and upper portion of the ureter and a lower incision to remove the remaining lower portion of the ureter (Fig. 675). We have used this method in 2 cases, but find that it has very little to recommend it, and have not employed it for several years. In women vaginal incisions have been used to remove the lower portions of the ureter below the broad ligament, but here again a simple extraperitoneal incision is usually all that is necessary.

FIG. 675.—Complete nephro-ureterectomy. Two extraperitoneal abdominal incisions. The kidney has been freed and brought out through lower incision. The ureter has been followed to its connection with bladder extraperitoneally and is doubly clamped previous to ligation and division with cautery.

The wisdom of ureterectomy has been discussed elsewhere. It may suffice here to say that in tuberculosis our experience has been that ureterectomy is rarely desirable and that it is safer to keep the tuberculosis confined within the fibrous ureter where it can be treated, if necessary, later.

TRANSPERITONEAL NEPHRECTOMY

Exposure of the kidney through an abdominal incision was in much more common usage in early days than it is at present. In fact, many of the early nephrec-

tomies were carried out transperitoneally and not infrequently the ureter was followed and stones removed through the abdominal route. With the progress of time, however, the extraperitoneal lumbar route has gained greatly in favor. Ureteral calculi are now almost never removed transperitoneally, and nephrectomy for stone, tuberculosis, and particularly for other infections, is carried out almost without exception extraperitoneally. In the case of horseshoe kidney the abdominal route still remains the method of choice and perhaps for certain very large intraperitoneally projecting cysts.

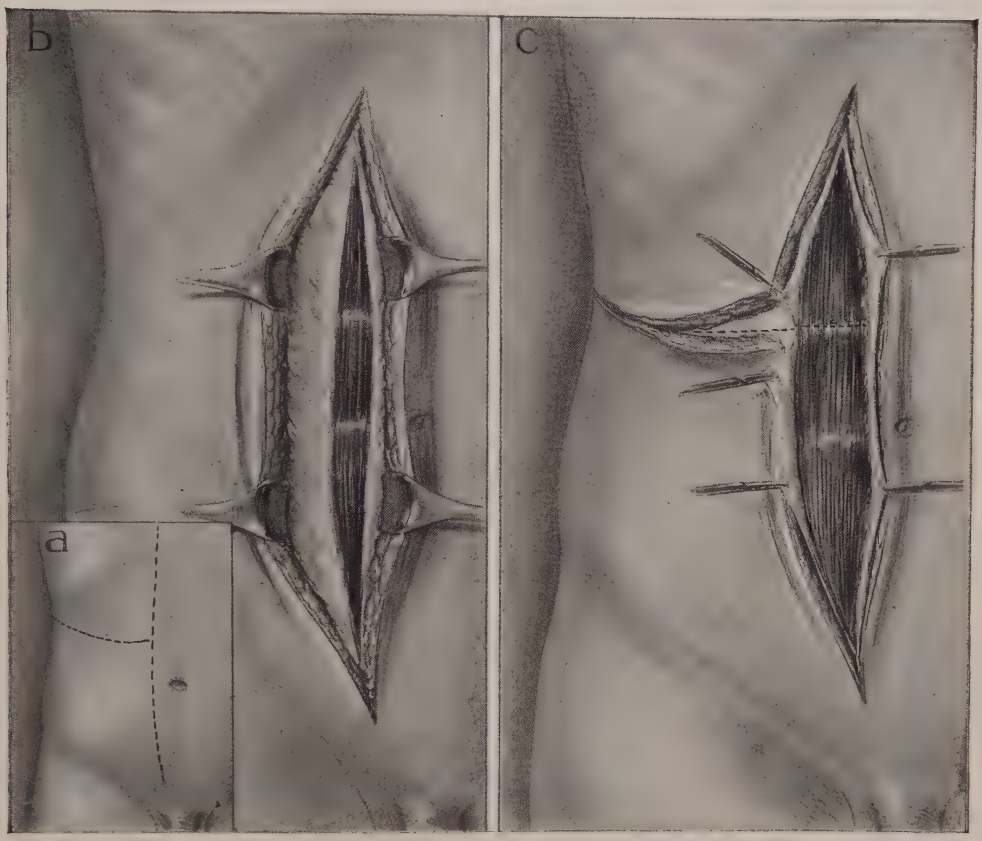


FIG. 676.—Transperitoneal nephrectomy for renal tumor: *a*, T-shaped incision; *b*, vertical incision near inner border of right rectus which is divided transversely at the first linea transversa, *c*, above the umbilicus. From here the fascia of the external oblique is divided transversely.

The one condition for which the transperitoneal operation seems to be the method of choice is malignant tumor of the kidney. We have not long been partisan to this approach in nephrectomy for malignancy, but a very careful study of our statistics, which we have recently made, shows a fearful mortality from recurrence and our attention is again directed to the transperitoneal route with the hope of carrying out more radical operations and obtaining better results. It seems probable that in some cases pressure upon the kidney during lumbar nephrectomy has forced tumor cells or juices into the blood-vessels, resulting in early generalization of the disease. As in the treatment of malignant disease elsewhere, it is certainly very desirable to locate the afferent and efferent blood supply at the

beginning of the operation if possible, and before pressure is made upon the tumor. This can never be done in the lumbar nephrectomy where it is necessary to use so much force in freeing the malignant kidney from its adhesions that substances may be forced into the circulation before the vascular pedicle is reached and clamped. More radical excision of fatty capsule and lymphatic structures about the renal pedicle is certainly desirable and cannot be carried out safely through the lumbar route. This and other reasons have caused us to operate upon renal tumors through the abdominal route and the technic to be described is that which we have found most satisfactory.

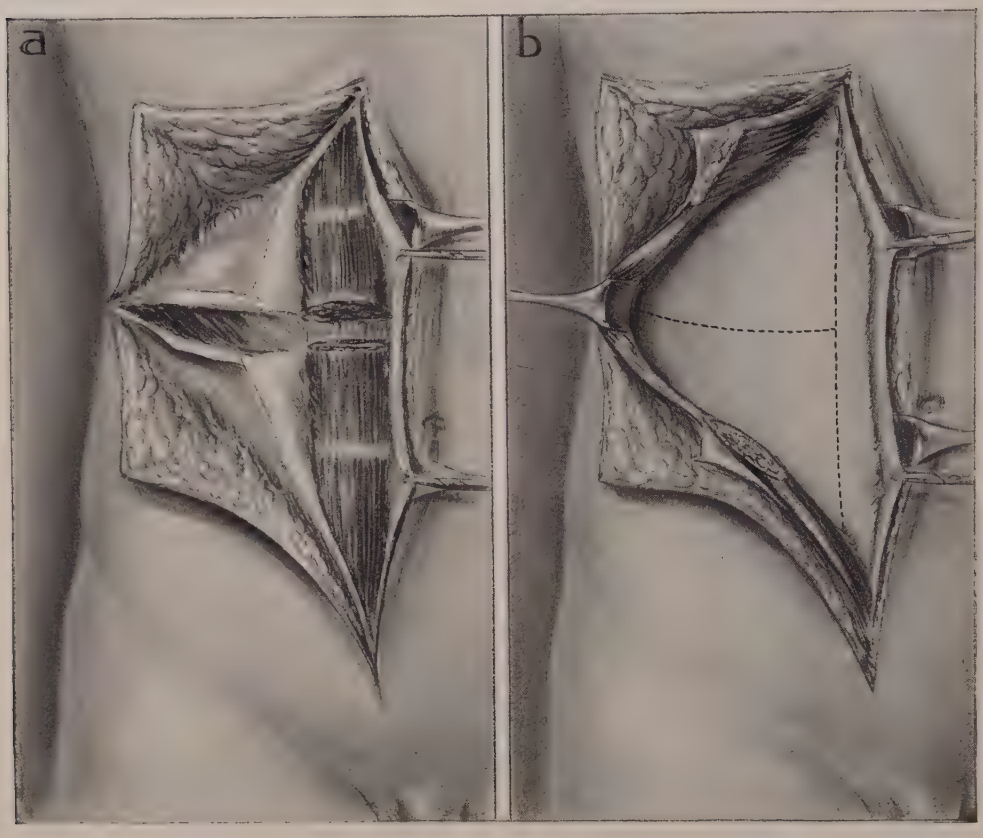


Fig. 677.—Transperitoneal nephrectomy through T-shaped incision: *a*, Rectus muscle and fascia covering external oblique divided, exposing external oblique, which is then retracted with muscles beneath it. *b*, Dotted lines show incisions to be made in peritoneum. Note that longitudinal incision in posterior rectus fascia is about 2 cm. from inner edge of rectus muscle.

Position of Patient.—The patient is placed on his back with the lumbar spine elevated upon a sand-bag or "kidney elevator."

Skin Incision.—A T-shaped incision with one branch along the inner border of the rectus about ½ inch from the median line and the other transverse passing outward at right angles just beneath the costal margin is employed (Fig. 676). The longitudinal incision extends along the inner border of the rectus from the costal border to within 2 inches of the pubes.

Abdominal Wall.—The fascia is opened about ½ inch from the inner edge of the rectus and the rectus is separated from it (Fig. 677), elevated, and

drawn outward, exposing the posterior fascia of the rectus, which we divide about 1 inch from the median line, being careful not to divide the nerves which are seen penetrating the posterior fascia to reach the rectus muscle. By so doing we believe a stronger wound is obtained when sutured. The transverse incision starts from a point about 2 inches above the level of the umbilicus and goes directly outward beneath the costal margin for a distance of 4 or 5 inches. The incision is quickly carried down through the linea transversa at that point and then through the fascia of the external oblique, which is not divided but forcibly retracted outward with the muscle beneath it. The posterior fascia and peritoneum are widely opened both transversely and longitudinally. The longitudinal incision

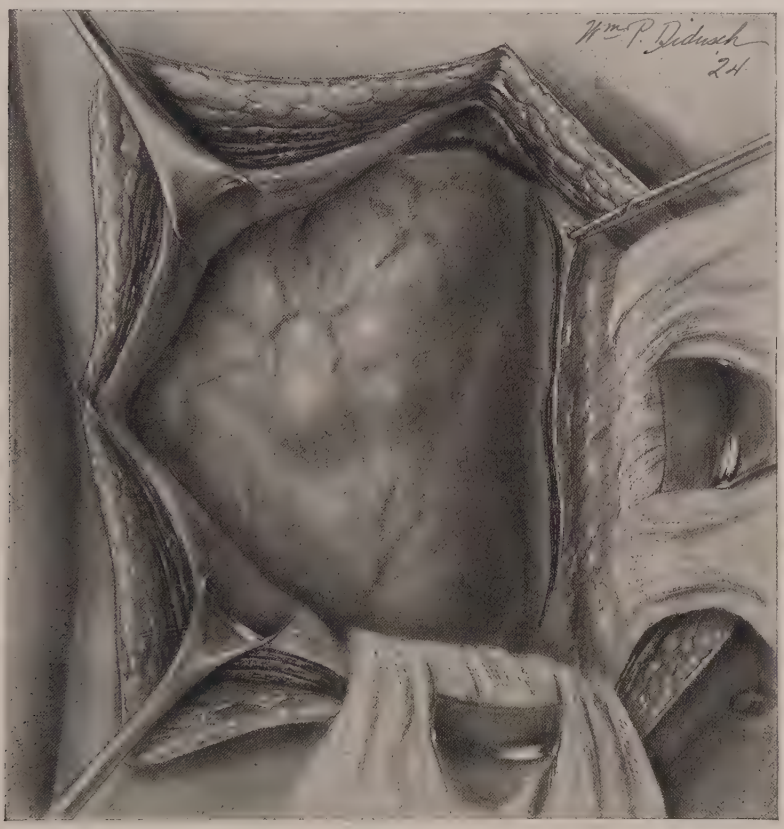


FIG. 678.—Transperitoneal nephrectomy. Incision through posterior peritoneum near inner edge of tumor on the right side.

reaches from the costal margin almost to the groin, as a wide exposure is desirable so as to avoid unnecessary pressure on the kidney tumor.

Exposure of Kidney.—As soon as the abdomen is opened the colon will be detected and should be pushed toward the median line, along with the rest of the abdominal contents, so that the tumor may be reached external to the mesocolon. With abdominal gauze pads and deep retraction the anterior surface of the kidney is brought into view and carefully palpated. Particular attention should be directed to the pedicle and the adjacent great vessels to make out, if possible, whether there is a prolongation of the tumor within them, as is not infrequently the case.

Separation of Kidney.—Nephrectomy having been decided upon, a vertical in-

cision is made external to the mesocolon along the inner border of the kidney as near as possible to the median line (Fig. 678), care being taken not to injure the bowel or its blood supply (which is always found along the inner side of the mesocolon and not externally). The incision through the posterior peritoneum should be sufficiently long to afford a wide exposure of the pedicle and adjacent portion of the kidney tumor mass above and below. Elevating the peritoneum, mesially, the greater vessels are approached, and the individual renal vessels exposed with as little manipulation of the tumor as possible (Fig. 679). The vessels should be clamped and triply ligated, either individually or in small groups, as previously

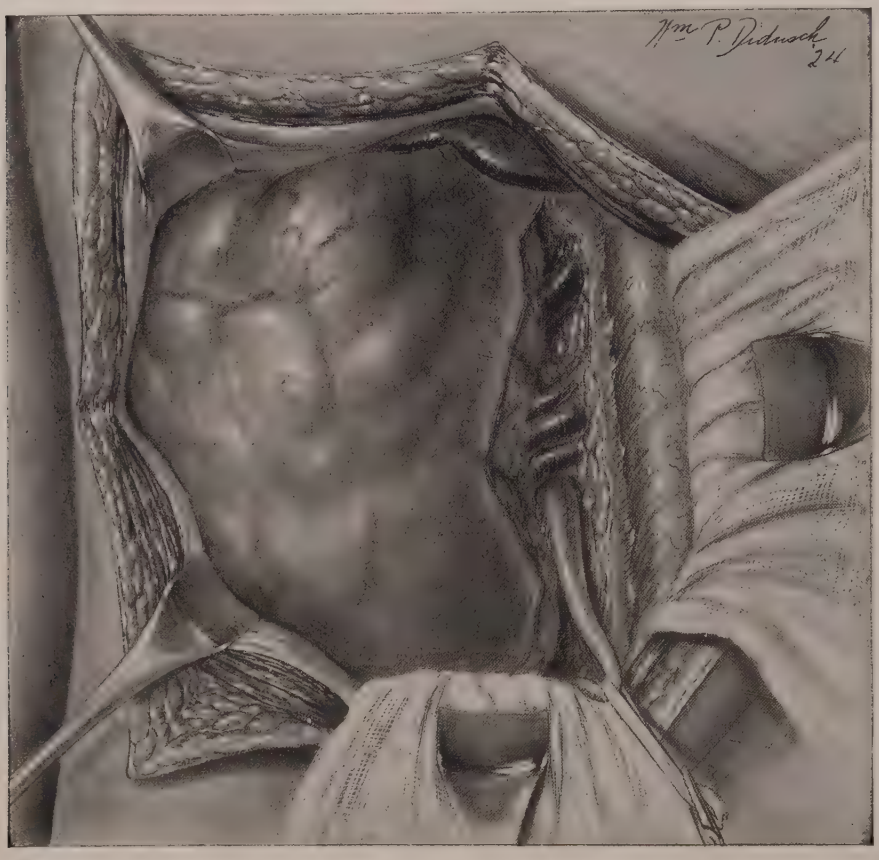


FIG. 679.—Transperitoneal nephrectomy. Exposure of vessels of pedicle and ureter (held up on tape).

described in lumbar nephrectomy. In some instances the vessels of the pedicle may enter behind the tumor mass or at one of the poles (when the tumor involves only one pole of the kidney, the other remaining healthy). In such cases it may be impossible to reach the vessels from in front, but even so, the abdominal incision gives much greater freedom of action.

Having exposed and ligated the vessels of the pedicle the excision of the kidney tumor is then carried out. We have usually found that there was considerable redundancy of the posterior peritoneum and that it was possible to remove all of the peritoneum covering the anterior surface of the kidney tumor. To do this, a circular incision is made through the parietal peritoneum so as to include the

peritoneum and fat covering the tumor and the kidney. Then beginning at the external border of the tumor mass the dissection is carried around the tumor above and below so as to free these surfaces of the mass from adjacent structures. The great advantage of this procedure, which we have not seen previously described, is that it avoids entirely the difficult separation of the peritoneum from the anterior surface of the kidney tumor and makes the operation much more radical. This technic, herewith described for the first time, is shown in the accompanying drawing (Fig. 680).

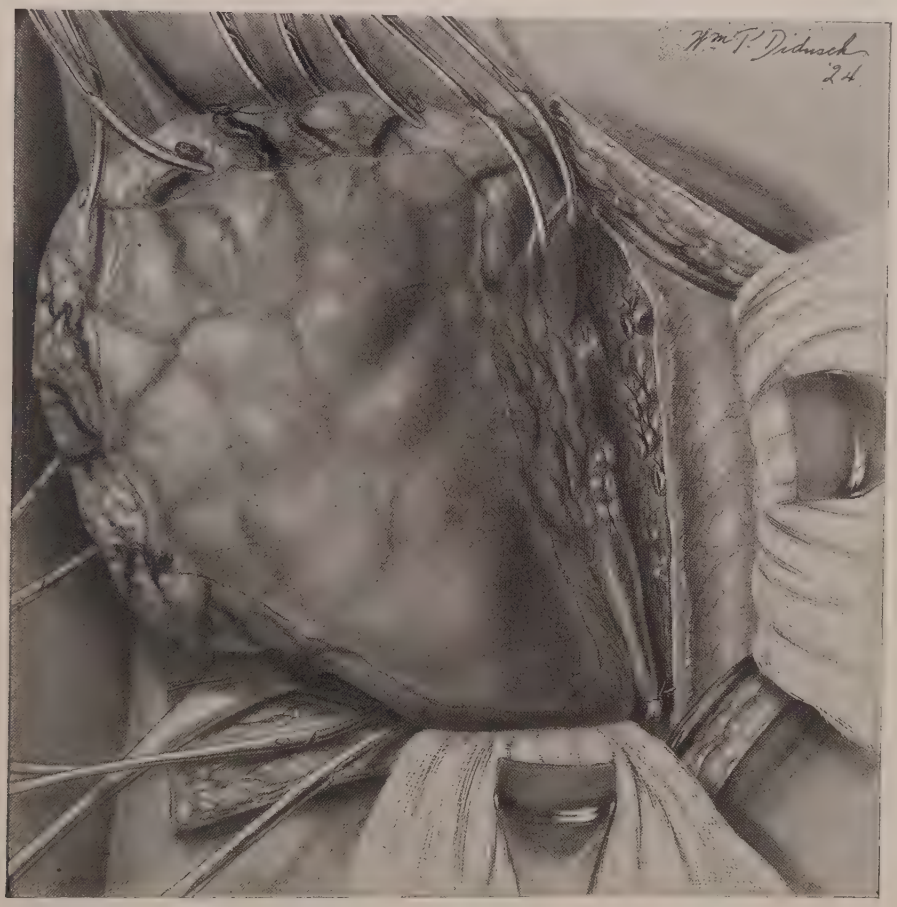


Fig. 680.—Transperitoneal nephrectomy. Young's technic; removal of peritoneal covering in one piece with tumor. This obviates much hemorrhage and danger of leaving invaded peritoneal tissue.

In freeing the kidney one should go as wide of it as possible and all important adhesions should be doubly clamped and ligated (Fig. 680), otherwise severe hemorrhage may be encountered. The ureter should be discovered as early as possible, clamped and ligated after following it a sufficient distance. When the kidney is removed as above described, with the peritoneum and fatty capsule, the adrenal gland will usually be seen and can be removed along with the tumor in one piece without difficulty. Its blood supply should be carefully ligated. The glands near the pedicle can also be removed in some cases.

Intravascular Tumors.—The well-known tendency of hypernephroma to develop within the renal vein and to penetrate into the vena cava, even to great distances, shows the great importance of careful examination of the pedicle. In a few instances intravascular growths have been removed with the tumor mass at operation. In one case the operator even carried his incisions into the vena cava, which was temporarily clamped above and below while the tumor mass was removed from within it. The wound was then closed by sutures, bringing the intima together.

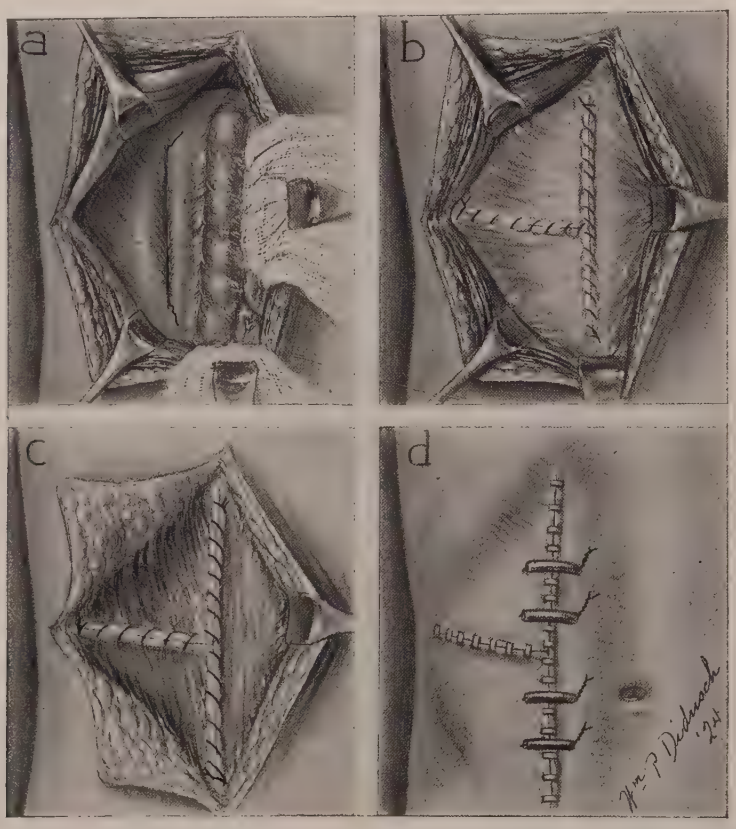


Fig. 681.—Transperitoneal nephrectomy, closure: *a*, Posterior parietal peritoneum approximated by continuous plain catgut. *b*, Peritoneum and fascia of rectus and transversalis approximated with continuous chromic catgut. *c*, Rectus muscle and fascia approximated (transversely) with heavy chromic catgut. Anterior fascia of rectus approximated with chromic catgut (vertical). *d*, Final closure, heavy wire stay-sutures through muscle and skin. Superficial approximation of skin with metal clips.

Closure.—After the kidney, with its fatty capsule, adjacent glands, and adherent layer of parietal peritoneum, has been removed in one piece, there remains a large defect in the posterior part of the abdomen. It is well to drain this by means of a stab wound which comes out in the back external to the quadratus lumborum muscle. Although a large area of peritoneum has been excised, no difficulty is experienced in approximating the edges of the remaining posterior peritoneum, which should be brought together by a continuous catgut suture so placed that the peritoneal surfaces are brought together (Fig. 681, *a*). The rest of the wound is closed completely; first, the peritoneum in both the longitudinal

and transverse directions (Fig. 681, *b*). The divided rectus muscle and its fascia and the fascia of the external oblique should be closed with heavy chromicized catgut. The primary incision through the anterior layer of fascia along the inner border of the rectus is similarly approximated. At the angle where the transverse and median incisions meet, the approximation should be reinforced by deep sutures of heavy catgut. The subcutaneous fat (if considerable) should be closed with continuous plain catgut and the skin with clips or interrupted or continuous sutures, as one may prefer. A few deep, supporting stitches of silver wire placed through skin, fascia, and muscle at a distance from the wound on each side may be desirable (Fig. 681, *d*). A rubber tube is placed extraperitoneally, emerging through a stab wound in the loin.

In a recent case which had previously been operated on and had a large ventral hernia, after closing the wound, we were able to plicate the redundant fascia of the anterior layer across the sutured wound and obtain a very strong abdominal wall and an excellent result.

The great *advantages* of the method that have been described are: greater accessibility to the pedicle for careful examination and radical excision of the glands and adjacent fat with the pedicle, the ability to remove the fatty capsule, parietal peritoneum, and adrenal along with the kidney tumor, a far more radical way with less hemorrhage and certainly less danger of squeezing the kidney juices into the circulation than if the operation is done through the lumbar extraperitoneal route. Time alone will show whether the results obtained are much more satisfactory than the older methods, which are certainly very unsatisfactory.

Implantation of Radium After Nephrectomy.—In certain cases of malignant tumor of the kidney the deeper structures have shown evidence of invasion so that it has seemed desirable to implant radium after nephrectomy had been carried out. In such cases it has been our practice to use metal tubes containing 1 mg. each of radium, which are inserted in the form of needles, to which a stout thread has been attached for subsequent removal. These are placed in the tissues at intervals of a centimeter and are allowed to remain from one to three days. Care should be taken that they are not placed in too great proximity to the great vessels. In some cases it may be very desirable to carry out surface applications of large amounts of radium directed through the back and sides to the region from which the tumor was removed and to regions in which metastases may be expected. A similar treatment with deep *x*-ray therapy may also be wise in certain cases and we have seen some remarkable improvement, particularly in relief of pain, result from such treatment.

OPERATIONS FOR RUPTURE OF THE KIDNEY

Traumatisms to the kidney are so varied in character and degree that it is impossible to lay down any standard course of treatment. In bullet wounds of the kidney it is frequently unnecessary to do more than afford drainage with or without removal of the projectile, depending on where it is located, the ease of extraction, and freedom from symptoms. Where considerable traumatism to the kidney has been done, and particularly if the bleeding is excessive, excision of the destroyed tissues with approximation of the wound surfaces may be indicated, or simple packing may be preferable.

The kidney should, as a rule, be exposed extraperitoneally, although the bullet may have passed through the peritoneal cavity. Proper investigations within the abdominal cavity should, of course, be carried out.

The kidney is occasionally wounded with knives, bayonets, etc. Here again the lumbar incision with either suture or packing should be carried out.

More extensive, and generally more common, are subcutaneous ruptures of the kidney due to various types of accident—such as falls or passage of heavy objects (automobiles, etc.,) over the abdomen. Such cases are often very difficult to diagnose. Blood may or may not be present in the urine and extensive hemorrhage—perirenal and extra- and intraperitoneal—may occur with few external evidences of what is going on. In some cases the patient may be almost exsanguinated from bleeding before rupture of the kidney is suspected. In such cases, if the blood has escaped into the abdomen and peritoneum, abdominal incision may be desirable both to explore the abdomen, evacuate blood, examine the kidney and do the necessary reparative operations. Where the peritoneum covering the kidney is not open the lumbar extraperitoneal route is preferable.

The incision should be sufficiently long so as to give an excellent exposure and space to do the necessary reparative procedures. The operator will be guided by what he finds present. Isolated portions of the kidney, which are more or less completely cut off from their blood supply, had best be removed; tears in the pelvis or ureter repaired if possible; ruptures of the kidney substance either brought together with sutures or packed; drainage with tube or gauze, if necessary, is supplied at the upper end of the wound. (See Chapter XXXIII, Urology in War.)

OPERATION FOR POLYCYSTIC KIDNEY

A lumbar, muscle-cutting, extraperitoneal exposure should be employed. In order to have free action a long incision is sometimes necessary owing to the huge size of the polycystic mass in these cases. As a rule, very few adhesions are encountered and good exposure of the mass of cysts is obtained. These, as a rule, are very thin walled with fairly deep intervening septa.

In uncomplicated cases the problem is simply to empty the cysts and to leave a condition which is least likely to recur. Puncture and simple incision are not as good as excision of the outer walls of the cysts, which provides better drainage and less chance of recurrence. Some authors have advised the use of the cautery in carrying out excision of the surface of the cysts. No difficulty is experienced in evacuating those cysts which are on the surface, but as many of them lie deep and are covered with fibrous tissue so that they are hard to reach, evacuation of all cysts is difficult to effect, and, in fact, almost impossible.

Complications, such as calculus either in the pelvis or calices or collections of pus—local or pyonephrotic—should be properly dealt with. Drainage is an important feature and should be provided for a considerable period so as to give vent to all secretions and to facilitate granulation of the surfaces in the hope of preventing recurrence of the cysts which have been resected. Elsewhere we have described the results which are to be found in the literature.

OPERATION FOR SOLITARY CYST OF THE KIDNEY

As mentioned elsewhere, these may be either large serous cysts or blood cysts. The latter are much more rare and the literature contains few operations for their

relief. The operative treatment for solitary cysts of the kidney has been exhaustively treated in the Journal of Urology in recent years.

Kretschmer[1] in 1920 collected 48 cases, in 16 of which nephrectomy had been carried out, in 18 either incision or resection, and in 1 the sac was sutured to the abdominal wound (marsupialization). Of the 35 patients operated upon, 2 died. He strongly urges resection of the cysts where possible.

In 1924 two extensive studies of the literature appeared. In the first, Harpster[2] presented 95 cases, 82 of which had been operated upon; 30 nephrectomies with 23 recoveries and 7 deaths (33 per cent.); 34 resections of either the cyst alone or of the cyst and part of the kidney, 3 deaths (10 per cent.); 4 cases in which the cyst was tapped, with 2 deaths; 14 cases in which the nature of the operation was not clear. He advised the method of Tuffier—a cuneiform resection of the cyst. The two angular surfaces of the wedge are then approximated by deep sutures of heavy catgut.

McKim and Smith[3] offer the latest very extensive paper, which is accompanied by an excellent discussion. They collected 120 cases, 107 of which had been operated upon with 11 deaths (10 per cent.). It is evident from a review of the literature that every effort should be made to make a positive diagnosis before operation is attempted. In case of abdominal tumor, where there is a possibility of its being renal in type, careful urologic studies should be made. As a rule, these cases should be recognized beforehand. A study of the literature shows conclusively that they should be attacked extraperitoneally by a lumbar, muscle-cutting incision. Complete removal of the cyst, generally with a thin, wedge-shaped area of adjacent renal tissue, in order to remove all secreting serous surface, should be carried out. The operation is simply that of renal resection, which is described and illustrated elsewhere. Hemostasis during the operation is effected by means of rubber-covered clamps across the vascular pedicle of the kidney. When the resection has been made, spurting vessels can be seen by releasing the clamps, caught with suture ligatures, and large veins may be similarly treated. Not infrequently a separate blood supply is found in the pedicle going to this part of the kidney, and its location assists materially in the hemostasis. Mattress-sutures of chromic catgut approximating the wedge-shaped margins of the wound in the kidney complete the hemostasis. The technic is shown in the paragraphs on resection. The mortality of these should be nil.

OPERATION FOR BLOOD-CYST

Giuliani[4] in 1913 was able to collect 12 cases, 4 of which had been operated upon by the lumbar, extraperitoneal route. All of these patients got well—one after resection and three after nephrectomy. Eight patients were operated upon by the transperitoneal route. In all of these cases the diagnosis was not made before operation and the mortality was high. Many of these blood-cysts are of traumatic origin and should be prevented by early operation in traumatisms of the kidney.

[1] Journal of Urology, 1920, iv, 567.
[2] Ibid., 1924, xi, 157.
[3] Ibid., 1924, xii, 635–661 (Lit.).
[4] Journal d'Urologie, May, 1913, 619.

OPERATIONS UPON HORSESHOE KIDNEY

In an excellent article upon operative treatment of horseshoe kidney and its complications Rathbun[1] carefully studied 108 cases which he had found in the literature. Of these only 24 had been diagnosed before operation. The remaining 84 were recognized for the first time at operation. In 4 cases diagnosis had been made by noting a mass on each side of the vertebral column connected by a palpable mass extending across the midline. Pain alone was present as a symptom in 31 cases, and tumor alone in 21 cases.

The pathologic lesions were as follows:

TABLE 155

Calculi	32	Trauma	2
Hydronephrosis	18	Pyelitis	1
Pyonephrosis	11	Ureter calculus	1
Tuberculosis (1 double)	12	Adhesions about ureter	1
Neoplasm	4	Fistula	1
Polycystic	3	Uncomplicated	13
Nephritis	2	No details	7

Of the operations performed there were 52 heminephrectomies, with 8 deaths (14 per cent.); 18 pyelotomies, 1 death (5.3 per cent.); 9 nephrotomies, with 2 deaths (22 per cent.); 6 divisions of the isthmus, 1 death (12 per cent.); 20 cases of operative exploration only.

Operative Technic.—This will depend entirely upon the conditions present and the operative indications. Where heminephrectomy is indicated a careful effort should be made to find a natural line of cleavage. With a wedge-shaped incision the edges of the kidney wound can be drawn together with mattress-sutures. If this is impossible, fascia or fat may be sutured against the raw kidney surface. The technic employed in cases of calculus is given in the history of the following case operated upon by Dr. Colston at this clinic:

Horseshoe Kidney with Calculus Blocking Pelvis on Left Side. Pyelotomy; Recovery.

B. U. I. 12,454, M. B., age thirty-three years. Admitted June 9, 1924. Eight months previously patient began having pain in left side of back, intermittent in character. About a month later had pain in back and radiating into the scrotum and left thigh. No fever or hematuria. In recent months patient has had a constant, dull pain in the back and left thigh with recurrent attacks of severe pain radiating into the thigh, scrotum, and penis.

Examination shows the right kidney not palpable; no tenderness to be made out over the kidney or in costovertebral angle. The left kidney is not palpable; no tenderness in the costovertebral angle, but slight tenderness is present on deep pressure anteriorly. Genital and rectal examinations negative.

Urinalysis.—Cloudy; acid; specific gravity, 1.018; albumin, trace; no casts; many white blood-cells and bacilli. Phenolsulphonephthalein: Appearance time, seven minutes. First hour, 60 per cent. Second hour, 10 per cent. Total, 70 per cent.

On cystoscopy, both ureteral orifices are normally placed and normal in appearance. A No. 6 catheter enters and easily ascends to the kidney on each side.

Urinalysis of separate specimens of urine as follows:

TABLE 156

URETERAL CATHETERIZATION

Date.		Color.	Character.	White blood-cells.	Red blood-cells.	Bacteria.	Culture.	Epithelial cells.	Urea.
6/8/24	Right.	Amber.	Hazy.	+	Occ.	0	Sterile.	+	20
	Left.	Amber.	Hazy.	+	+	0	Sterile.	+	22

[1] Journal of Urology, 1924, xii, 611 (Lit.).

Thorium nitrate, 15 per cent., was introduced into the left kidney and pyelogram taken. Plain *x*-ray was also taken. This showed a shadow in the region of the left kidney, which was diagnosed calculus (Fig. 682), and the isthmus of a horseshoe kidney could be seen.

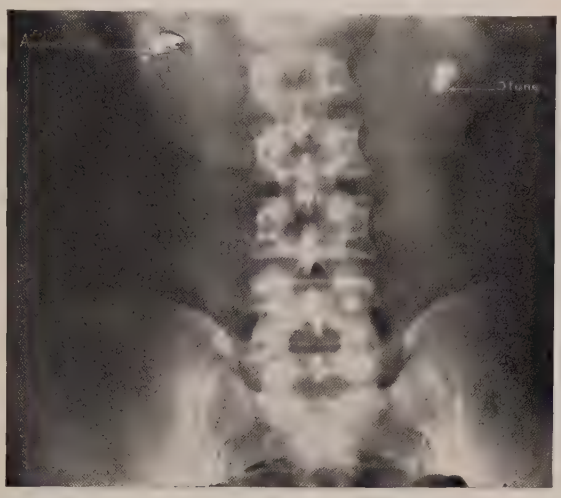


FIG. 682.—*x*-Ray showing horseshoe kidney with stone in the left half. Note that the isthmus connects the lower poles. B. U. I. *x*-Ray 5215, B. U. I. 12,454.

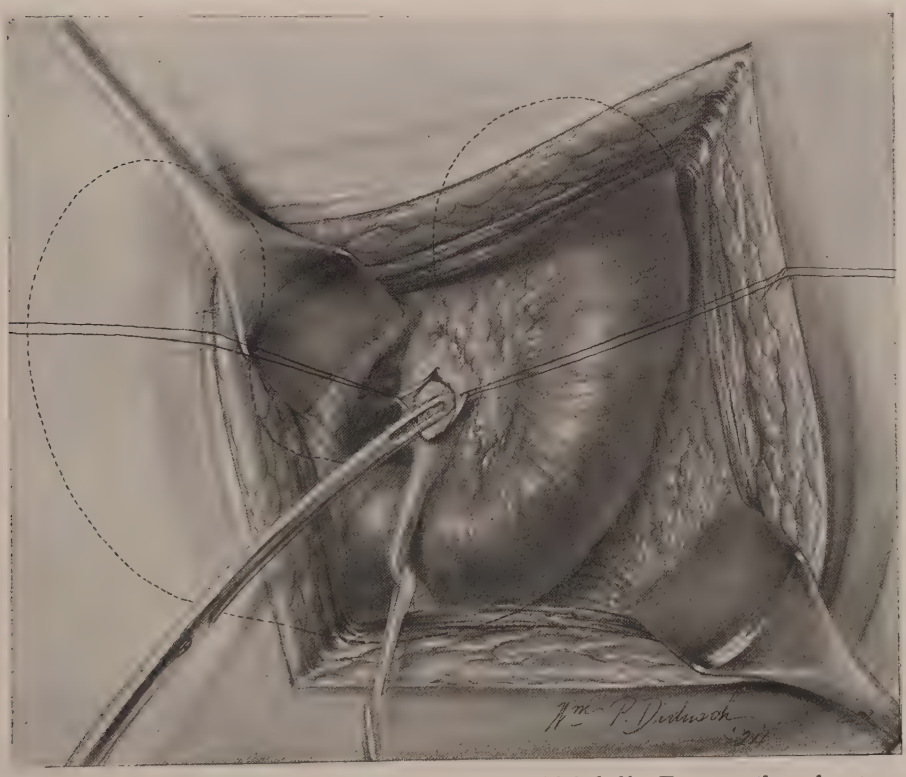


FIG. 683.—Case of horseshoe kidney with stone in pelvis of left half. Exposure through extraperitoneal incision, pyelotomy, removal of stone. B. U. I. 12,454.

June 11, 1924: Operation, Colston; gas and oxygen. Lumbar extraperitoneal incision; exposure of left half of horseshoe kidney. Pyelolithotomy: Removal of a stone measuring 1.5

by 1 by 1 cm. in size. Incision in pelvis closed with continuous fine catgut. Muscle and skin approximated with catgut; tube drainage at upper angle of wound.

The usual curved skin incision was made. Muscles divided and the superior lumbar triangle exposed and opened. Kidney fat recognized and broken through, exposing kidney, which was then separated by blunt dissection from adhesions at the upper pole. On freeing the lower pole, it was found that the diagnosis of horseshoe kidney was correct, as an isthmus of renal tissue could be felt extending from the lower pole across the great vessels, where it was continuous with the lower pole of the right kidney. The kidney could not be mobilized or brought into the wound. The ureter passed in front of the isthmus and was apparently dilated. It was followed up to the inner surface of the left half of the horseshoe kidney. One aberrant vessel which crossed at about the ureteropelvic junction was ligated. The pelvis was then carefully separated from surrounding structures and a good exposure obtained, but the stone could not be felt. The pelvis was opened, and with a probe, the stone was felt in the lower calyx, from which it was easily removed. The accompanying drawing made at the time of operation accurately shows the conditions present (Fig. 683).

Convalescence uneventful.

Phthalein appearance time, fourteen minutes; elimination for two hours, 55 per cent. The urine is clear; contains a few leukocytes, apparently no bacteria. Wound well healed and the patient is in excellent condition. Discharged on the twentieth day.

OPERATIONS ON ECTOPIC KIDNEY

Operative indications are much the same as for a kidney in a normal situation. It will not be necessary to discuss the variations and technic here, sufficing simply to state that the multiplicity of vessels and the complexity of their arrangement must be carefully studied so as not to expose the patient to danger of hemorrhage.

When the kidney is healthy but mobile, nephropexy may be indicated. The operation, however, is much more difficult than in the ordinary mobile kidney, owing to the difficult location and number of blood-vessels and the completely intraperitoneal nature of the kidney in many cases. If there are no symptoms or signs of disease aside from the malposition alone, there should be no interference.

OPERATIONS ON THE RENAL PELVIS AND ADJACENT URETER

Various operative procedures have been proposed for the direct treatment of hydronephrosis, which may be classified as (*a*) those designed to reduce the size of the sac itself, and (*b*) those designed to cure by a plastic procedure the ureteral constriction causing the hydronephrosis.

In the first class may be placed operations in which the sac is plicated, and those in which resection of part of its walls is performed. The operations for plication are carried out by introducing mattress-sutures in the walls of the sac, which, when drawn tight, cause the walls to fold together and obliterate part of the lumen. In resection, portions of the wall are removed, and the edges brought together by Lembert or mattress-sutures to reconstruct the pelvis. It may be done in such a manner as to bring the ureteral orifice to the most dependent point, or to remove a large dependent sacculation. In both types of operation it is important to avoid having the sutures or incision include functioning renal tissue or important blood-vessels. The operations of plication date from times when the mechanism of hydronephrosis was not as fully understood as at present, and can, of course, have no good result if the obstruction causing the hydronephrosis is still present. It is possible to combine resection with removal of the obstruction in some cases,

but in our opinion both plication and resection are seldom if ever justified. The removal of the obstruction is the most important thing, and if this is accomplished, the kidney will function just as well if nothing further is done, provided it is not infected. If it is infected, the additional trauma of the operation on the kidney itself will make the infection only more difficult to eradicate, and the likelihood of a good result more remote.

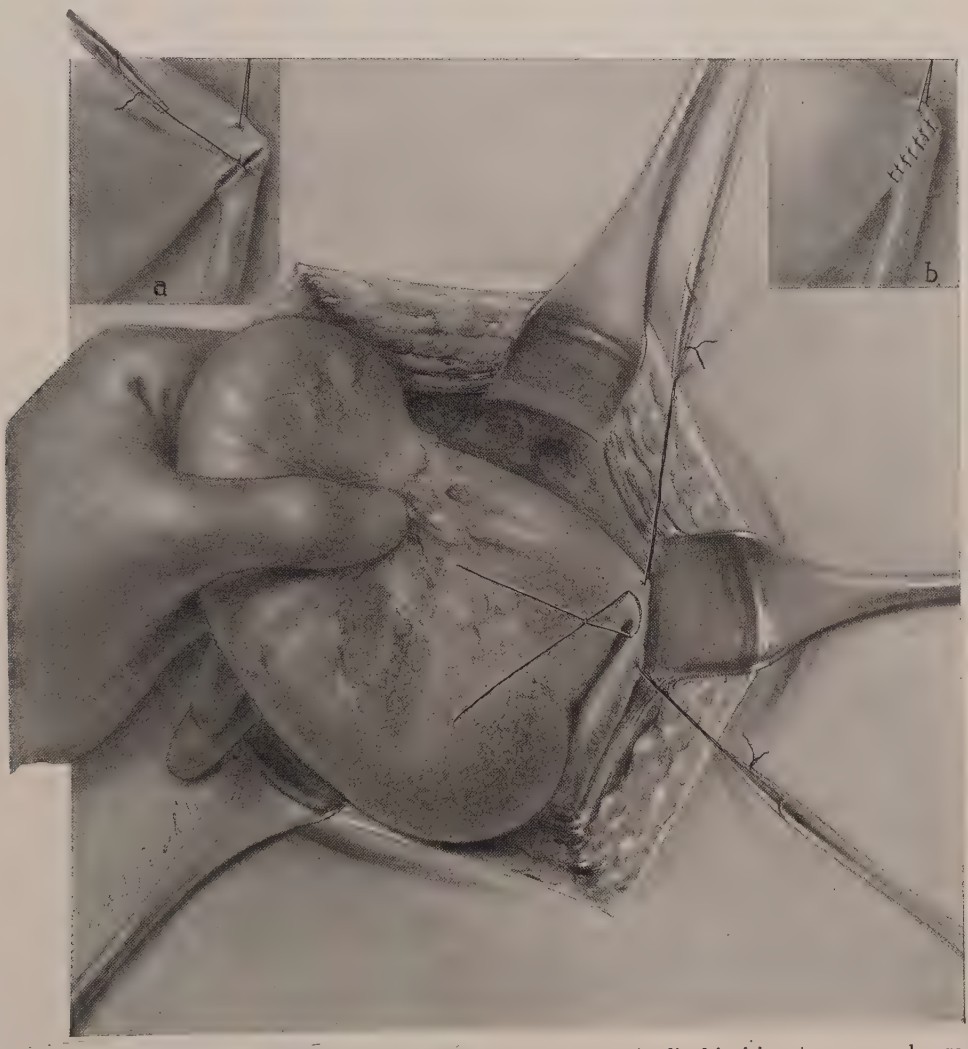


FIG. 684.—Operation for stricture at ureteropelvic juncture. Longitudinal incision, transverse closure, *a* and *b* (ureteroplasty).

Plastic operations on the pelvis and adjacent ureter are indicated in a restricted number of cases in which the obstruction involves the ureter for only a short distance, and at a point near enough to the pelvis so that the procedure can be completed without producing tension.

Such operations should be reserved for congenital or inflammatory strictures at the ureteropelvic junction, and should only be done when the condition of the kidney is such that the possibility of its future functional usefulness is not so remote

that it fails to justify the risks of the operation. When the other kidney is removed or injured by disease, greater risks must be taken. The principles to be followed in all cases are to have the anastomosis at the most dependent point of the pelvis, and to avoid all tension. Legueu[1] recommends a preliminary nephrostomy, but

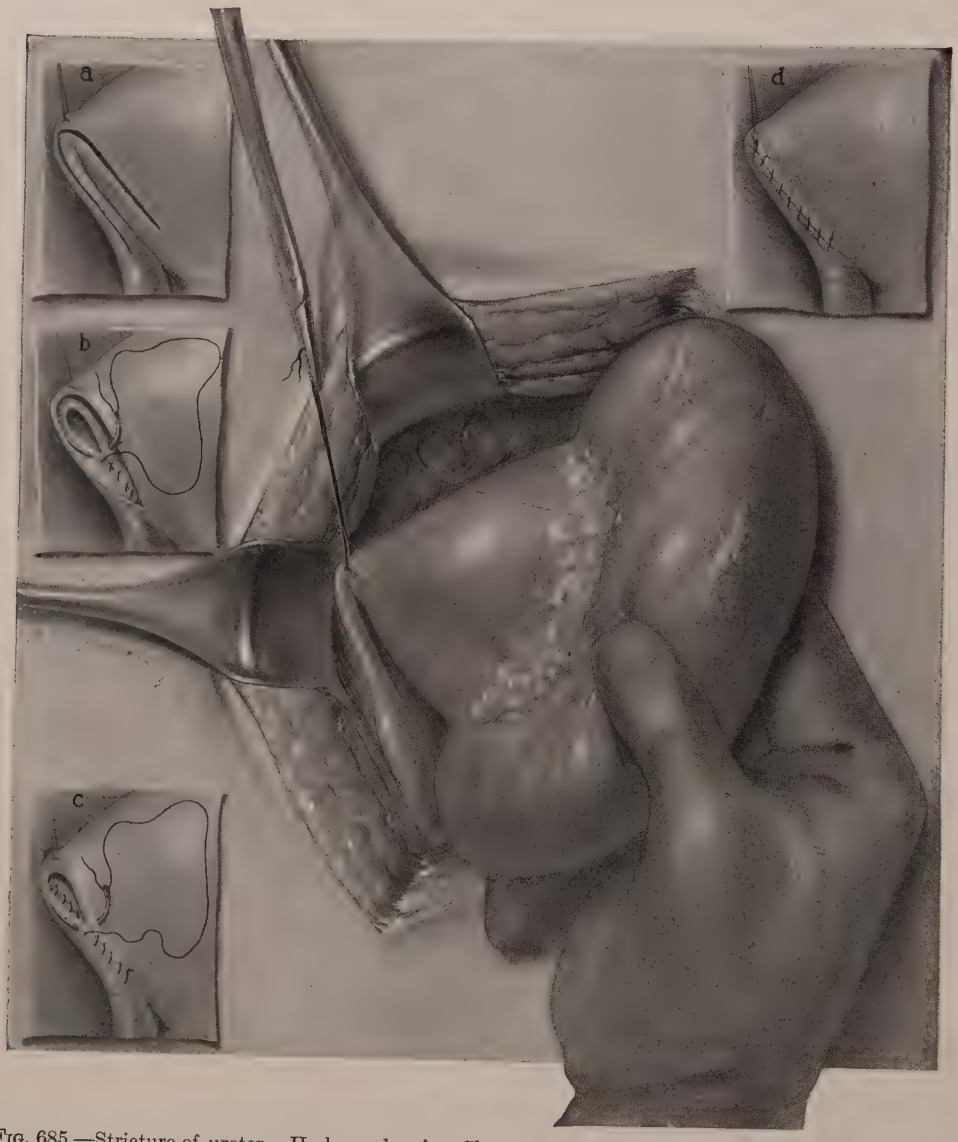


Fig. 685.—Stricture of ureter. Hydronephrosis. Showing various steps (*a*, *b*, *c*, *d*) in plastic operation (ureteropyeloplasty) for correction of extensive narrowing of ureter at pelvic juncture.

we believe that this is seldom necessary except to relieve uremia when the opposite kidney is not functioning.

The procedures commonly recommended are: (*a*) Ureteroplasty, according to the principle of Heinecke, or that utilized by Finney in his pyloroplasty, at the

[1] Traité Chirurgical d'Urologie, 2d ed., Paris, 1924, 1534–1576.

ureteropelvic junction, (*b*) lateral pyelo-ureteral anastomosis, and (*c*) anastomosis of the cut end of the ureter and the pelvis, or ureteropyeloneostomy.[1]

Ureteroplasty is practicable only when the stricture is just at the ureteropelvic junction, and not more than 0.5 cm. in length. It is accomplished by slitting the ureter longitudinally and reuniting the edges in such a manner that the two ends of the incision are drawn together, converting it into a transverse one, as shown in the accompanying picture (Fig. 684). When the stricture is longer, it may be incised throughout its length, and an incision of similar length made in the pelvis, leading to its most dependent point, and joining the ureteral incision. The edges of the two incisions are then sutured together like the familiar pyloroplasty, as shown in Fig. 685.

If the ureter enters the pelvis at a point well up from the most dependent area, a simple lateral *anastomosis* between ureter and pelvis may be made at the most dependent point of the pelvis. Incisions of the same length are made in the two, and joined as in lateral entero-anastomosis. Care must be taken to avoid turning in the edges enough to obstruct the lumen, and also to avoid any kink at the distal end of the anastomosis—which latter is quite apt to occur.

If none of the above procedures is possible, the stricture may be completely excised, and the upper end of the ureter sutured into an aperture made at the most dependent point of the pelvis (*ureteropyeloneostomy*). If the end of the ureter is beveled to increase its circumference, this may be done by a simple circular suture of interrupted stitches (Fig. 686) or the ureter may be split and the two ends fastened to the internal surface of the pelvis at a little distance on either side of the aperture. The strictured area, or part of it, may be used for these split ends. The object of the latter procedure is to avoid any sutures whatever in the intact portion of the ureter, which is so small that there is always danger of constricting its lumen.

Fine plain catgut is used in all these plastic procedures. Some surgeons have employed silk when the urine was sterile, but there is always danger of a silk suture finding its way to the surface of the urinary tract, where it will probably cause stone formation. Through and through sutures, taken very near the edge, and including the mucosa, have been recommended, but it is probably better to include only the adventitia of the ureter and pelvis, taking the sutures with the greatest care so that the mucosal edges, while not included in the suture, are very accurately approximated. The knots are tied outside. Thorough tube drainage to the suture line should be provided, as some leakage of urine is to be expected. Gauze should not be used, as it may adhere to the suture line and disturb it when removed. Separate drainage of the pelvis is advantageous in some cases, especially infected ones. Should a catheter or bougie be left in the ureter? There is considerable doubt on this point. The passage of bougies after operation is important, but often difficult or impossible. With a bougie or catheter in place, patency of the lumen is assured and the pelvis may be drained, but on the other hand, it is difficult to keep it there long enough for complete healing to take place, and the presence of a foreign body aggravates infection. It is probably better omitted.

The principal *complications* ordinarily met with in operations of this kind

[1] Bazy: Encyclopædie Française d'Urologie, Paris, 1914, iii, 133–182. Albarran: Médecine Opératoire des Voies Urinaires, Paris, 1909. Geraghty and Frontz: Journal of Urology, 1918, ii, 161–209.

are aberrant vessels, bands of adhesions, and abnormal mobility of the kidney. In the case of aberrant vessels, one should make sure that the vessel is really causing obstruction, and if so, that it cannot be relieved by the plastic operation or by nephropexy without disturbing the vessel. If small, the vessel may be divided, but if larger, it must be remembered that since there are no arterial anastomoses in the kidney, the ligation of any artery of that organ will cause degeneration of the portion of the kidney supplied by it. Quinby[1] shows how in some cases where

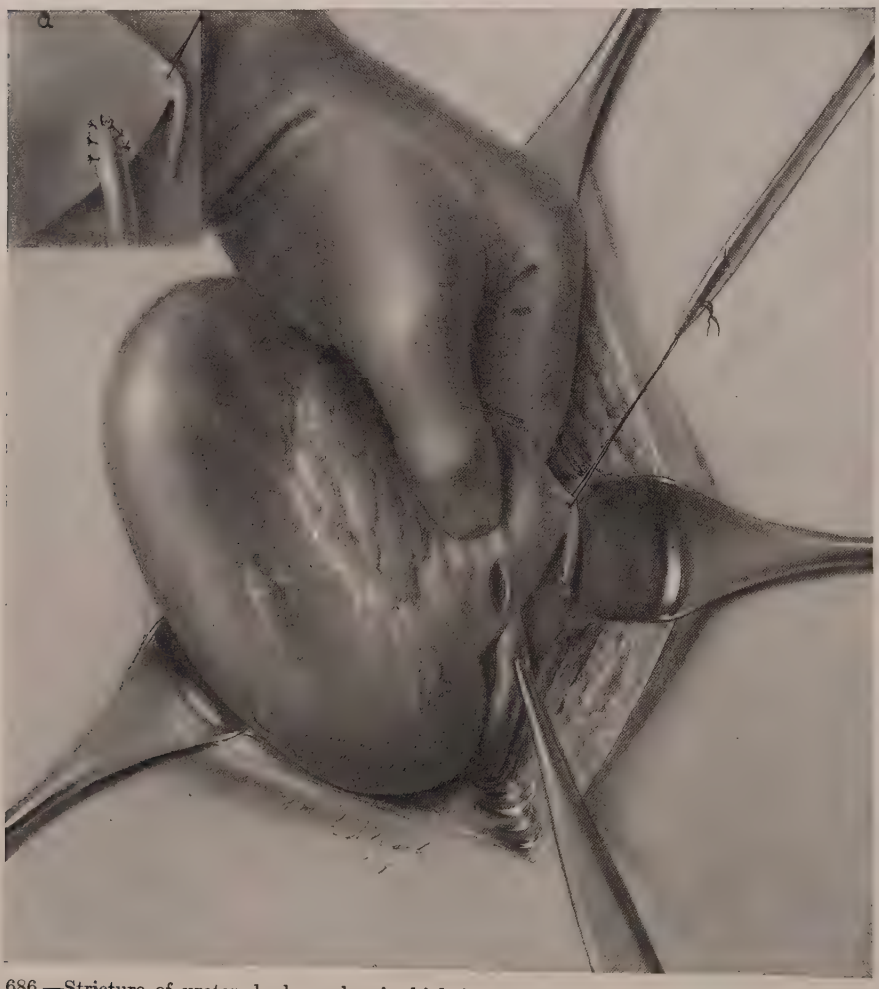


FIG. 686.—Stricture of ureter, hydronephrosis, high insertion of ureter, transplantation of ureter to lower end of pelvis. *a*, Closure by sutures (ureteropyeloneostomy).

the ureter extends up above the vessel and is compressed by it, it may be removed from the influence of the aberrant vessel by performing ureteropyeloneostomy at a point on the pelvis below the vessel. Bands of adhesions should be divided so that the ureter is completely freed. Abnormal mobility of the kidney may be an important contributing cause in high ureteral obstructions. This should be investigated by moving the kidney about during its exposure. If abnormal mobility

[1] Transactions of the American Association of Genito-Urinary Surgeons, 1922, xv, 43–64.

exists, it is usually best to perform nephropexy, and in some cases this may make it unnecessary to do anything further.

Complete excision of ureteral strictures with end to end, side to side, or end to side uretero-ureteral anastomosis is usually unsuccessful, since it is almost impossible to perform such anastomoses without subsequent stricture formation.

The *results* of the above operations are always doubtful. Immediate success may be followed by late stricture formation and recurrence of the troubles. Legueu was able to collect only 8 cases where a successful result had been followed for more than fifteen months. Quinby adds another. In six of these ureteral catheterization had confirmed the result. In general, whenever the opposite kidney is normal, and the hydronephrosis is of considerable size, hesitation is justified, since while nephrectomy is curative, an unsuccessful plastic will only prolong the patient's illness. If the hydronephrosis is early and uninfected, one should give the patient the chance of retaining two good kidneys by performing a plastic when possible. If the opposite kidney is damaged or absent, one should certainly try a plastic before resorting to nephrostomy. Legueu divides the indications for these operations into those of "choice" and those of "necessity," which is an excellent way to regard the problem. He also notes that the most good results are secured after simple ureteroplasty, the outcome after pyelo-ureteroneostomy and lateral anastomosis being more doubtful.

In our clinic, 4 cases of 5 upon which plastic pelvic operations were done have been followed.

B. U. I. 10,383, age thirty-eight. Pain in right side for three years. On examination, large palpable tumor. Pyelogram showed large extrarenal hydronephrosis, ureter normal. Urine clear and uninfected. Operation: Ureteropyeloplasty. Two years and eight months later the patient reports himself as entirely well.

B. U. I. 5721, age nineteen. Dull pains in lumbar region for five or six years, growing progressively worse. Pyelogram showed large left hydronephrosis, ureter normal but leaving the pelvis at an acute angle. Urine clear and uninfected. Operation: Ureteropyeloplasty. Double pyelogram taken six months later showed another large hydronephrosis on the right side, although the patient was free from symptoms. On the left side, the pelvis had diminished only 10 or 15 per cent. in size, but the calices, which before had been large and globular, were now contracted to normal size and showed perfectly normal cupping at their ends. The insertion of the ureter into the pelvis was changed to the most dependent point. Seven years and nine months after operation, the patient reports himself as entirely well, with no further treatment.

B. U. I. 4521, age thirty-five. Periodic attacks of pain in left side for fifteen years, accompanied by nausea and vomiting. Examination showed a good sized right hydronephrosis and a very large left hydronephrosis. A few bacilli in the left kidney urine. Operation: Ureteropyeloplasty and freeing of adhesions about the ureteropelvic junction (left). Although no phthalein had been obtained from this kidney before operation, the parenchyma was in good condition, therefore, there had probably been a retention of phthalein in the greatly enlarged pelvis. Nine years after operation, the patient reports himself as entirely well.

B. U. I. 11,199, age twenty-three. Pain in lumbar region for some years. Examination showed a large hydronephrosis with the ureter constricted and distorted below it. Urine infected. Operation: The ureter was dilated below the stricture, which was nearly 2 cm. long. An extensive operation was done, with resection of the entire mesial portion of the (extrarenal) sac and of the strictured portion of the ureter. The upper end of the dilated portion of the ureter was anastomosed to the most dependent point of the pelvis, and the remainder of the pelvic defect closed with mattress-sutures. The pelvis was not drained. Nine months after operation the pain is still present, and it seems probable that the stricture has re-formed, and that nephrectomy will be necessary.

This adds three more successful results which have been followed over two years, a total of twelve.

CHAPTER XV

OPERATIONS ON THE URETER

EXPOSURE OF THE URETER

Extraperitoneal Exposure of the Ureter.— *Upper Portion.*—The incision here is practically the same as for a lumbar extraperitoneal operation upon the kidney. If one believes that it will not be necessary to free the kidney completely, particularly at its upper portion, the wound need not be so high. It should, however, be sufficiently long to obtain a good exposure. The fascia and fatty capsule of the kidney are stripped aside, as previously described, and the lower pole of the kidney exposed. Raising the lower pole of the kidney, the operator tries to obtain a view of the ureter as it passes downward from the ureteropelvic juncture. By recognizing the ureter here, it is easy to free it from its surrounding structures and follow it downward to the necessary distance. In some cases, however, where the kidney is difficult to displace, the ureter may not be found with ease by the method above described and one usually has to search for it blindly with the finger and thumb.

When the peritoneum is pushed forward the ureter is generally carried with it, as remarked before. In cases of marked periureteritis (tuberculosis, etc.) there may be very firm adhesions to the muscle posteriorly and the peritoneum may strip off more easily so that the ureter has to be sought for behind.

The ureter can usually be recognized as a fairly firm tube about the size of a small lead pencil in normal cases. It can usually be stripped from the peritoneum by means of the index-finger or with a curved clamp, there being little danger of penetrating the peritoneum, to which it is more or less loosely attached. One must remember that the spermatic or ovarian vessels (vein, artery, and lymphatics) are found in fairly close proximity to the ureter in its upper portion and that, a little lower down, they cross in front of it. Occasionally this cord of vessels is about the same size and consistence as the ureter, but when drawn up upon a clamp or a cotton tape the character of the tissues included can usually be recognized at once.

Where the ureter is markedly pathologic it is usually enlarged, thickened, and sometimes greatly dilated, and as a result much easier to discover by palpation. In some cases it is so greatly dilated that it may simulate a coil of small intestine, particularly if it is embedded by adhesions in the posterior surface of the peritoneum so that its contour cannot be recognized. In several cases we have hesitated and investigated for quite a time before being able to assure ourselves that we were dealing with a greatly dilated ureter, but when the decision was finally made little difficulty was encountered in freeing the ureter from the peritoneum and drawing it up into the wound.

As the freeing process extends downward one encounters small vascular twigs which supply the ureter. In some instances they can be recognized, clamped, and divided, but, as a rule, they are of such small size that they are torn and do not

require ligature. Occasionally bleeding is sufficiently pronounced to require search for the bleeding point, clamping, and ligature.

Through an ordinary extraperitoneal kidney incision the ureter can usually be explored to the point where it crosses the iliac vessels, and through such an incision small stones can often be discovered and drawn upward to a higher point where they can be removed through the original incision without difficulty. In many instances, however, particularly where deep-seated operations upon the ureter are required, it will be necessary to enlarge the original incision.

Middle Portion of the Ureter.—Where the kidney has been explored as above described, the incision may be carried downward beyond the level of the crest

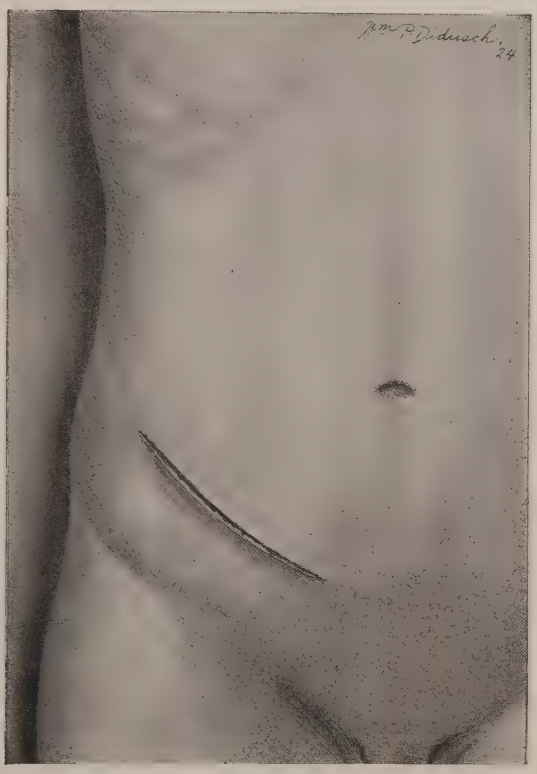


FIG. 687.—Incision for extraperitoneal exposure of ureter at pelvic brim by muscle-splitting technic. Inner edge of incision just within border of right rectus muscle.

of the ilium and, if necessary, obliquely inward. The incision includes skin, fascia, and muscles, the peritoneum being pushed up and the lower portion of the ureter exposed as desired. Such an incision will generally suffice to explore the entire ureter.

The median portion of the ureter approaches the great blood-vessels and at their point of bifurcation is about 6 cm. from the ureter on the opposite side. One is in little danger of injuring the iliac vessels because the ureter will have been stripped up with the peritoneum. In some cases, however, the adhesions may be very close and some care is necessary in this part of the operation. The proximity of the spermatic (or ovarian) vessels should be recognized as they generally lie immediately external to the ureter about its middle, and below they diverge, passing outward

and downward along the posterior surface of the peritoneum. Where one wishes to attack the median portion of the ureter and not investigate the kidney an incision may be made which is the same as that used for the lower portion of the ureter which is described below.

Lower Portion.—We usually employ a muscle-splitting extraperitoneal operation. The skin incision generally starts at a point above the level of the anterior-superior spine, at a distance of 1 inch from it (Fig. 687). From there it goes downward and inward, curving slightly upward until the median line of the abdomen is reached. The fascia covering the external oblique and the anterior surface of the rectus is exposed by blunt dissection with gauze. As the fascia forms the greatest barrier to a good exposure, this should be incised for a greater distance than the rest of the wound. It is well to divide the fascia of the rectus transversely to the median line (Fig. 688) and then to carry the incision through the fascia of the external oblique upward and outward along the line of the skin incision until

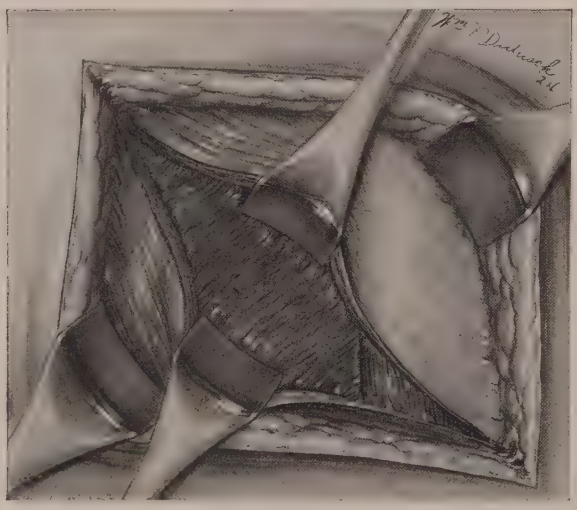


Fig. 688.—Extraperitoneal exposure of right ureter at pelvic brim. Muscle-splitting operation. The fascia and external oblique have been divided along the course of their fibers. The fascia of the rectus has been divided to the median line. The rectus and internal oblique are exposed.

somewhat beyond the upper angle of the skin wound. The aponeurosis, thus divided, is pulled aside with retractors, so as to expose well the external oblique muscle. With the handle of the scalpel a rent is made between the fibers of the muscle in the direction of the wound (Fig. 688). The muscle edges are then retracted forcibly so as to expose the internal oblique as widely as possible. By blunt dissection a rent is then made in the substance of the internal oblique about the middle of the wound (Fig. 689). After retracting the edges of the internal oblique one next sees the fibers of the transversalis, in which a rent is then made between the fibers (Fig. 690), thus producing a transverse wound which should be enlarged as much as possible in order to expose the external surface of the transversalis fascia, which is then divided in the direction of the skin wound.

Care must be taken not to injure the peritoneum, which lies immediately beneath the fascia. It is often well to make a small nick in the transversalis fascia, then to insert a grooved director between it and the peritoneum and divide the fascia upon it (Fig. 691). Having freed the peritoneum the operator then inserts his

fingers on both sides and retracts the wound as widely as possible, exerting considerable force, and then using large retractors. A wound 3 or 4 inches in diameter is thus easily secured.

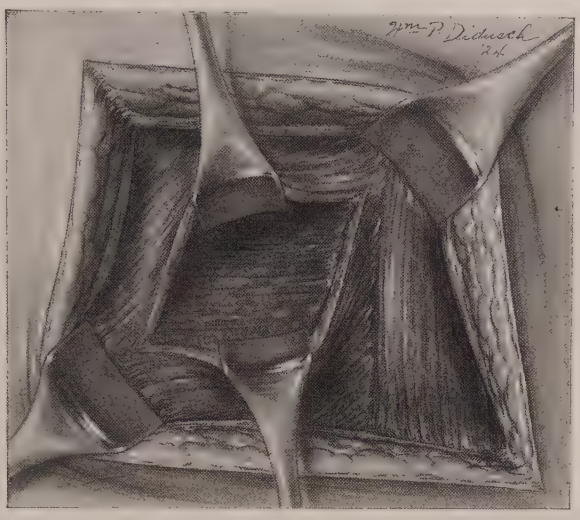


FIG. 689.—Extraperitoneal exposure of ureter at pelvic brim. Muscle-splitting operation The internal oblique is split along the course of its fibers and retracted, exposing the transversalis beneath.

By blunt dissection externally the peritoneum is then separated from the adjacent parietal wall of the abdomen and the iliac fossa. This part of the operation proceeds rapidly, and there is little danger of tearing into the peritoneum which

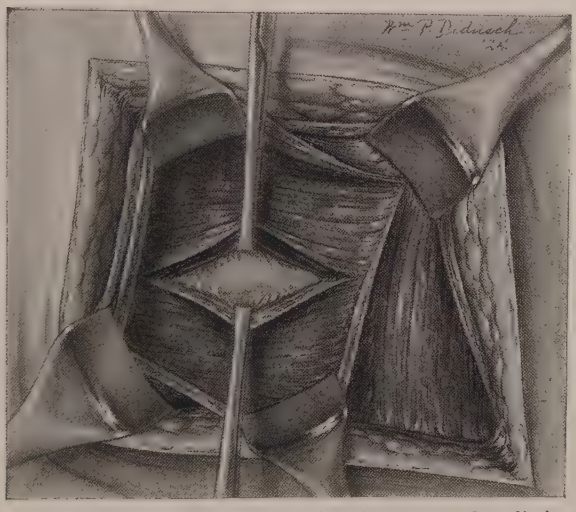


FIG. 690.—Extraperitoneal exposure of ureter at pelvic brim by muscle-splitting technic. Separation of fibers of transversalis muscle.

should be followed externally, posteriorly, and then internally until, with the finger, one palpates the psoas muscle and the spinal column. Continuing the peritoneal elevation one may feel the aorta, or on the right side the vena cava, and below them the iliac vessels. Examining the elevated portion of the perit-

oneum one can usually see the spermatic vessels as they travel upward and inward upon the posterior surface of the peritoneum. The ureter is generally invisible, but can usually be found by palpation upon the posterior surface of the

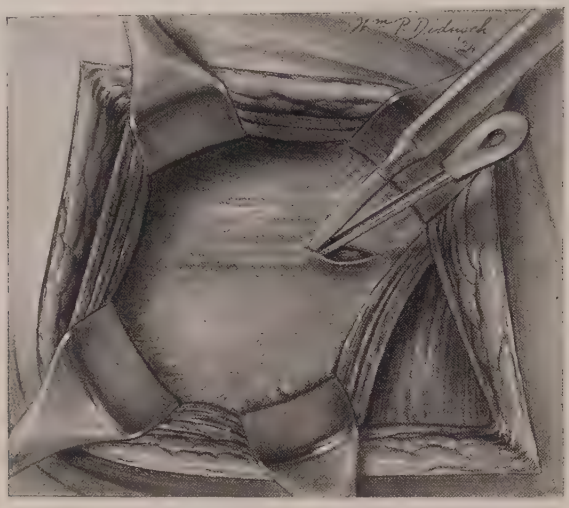


FIG. 691.—Extraperitoneal exposure of ureter at pelvic brim by muscle-splitting technic. Division of transversalis fascia on grooved director.

peritoneum where it is more or less loosely attached. It can generally be separated with the finger sometimes assisted with a long, markedly curved clamp (goose-neck forceps) (Fig. 692). Where the ureter is enlarged it can be recognized with great

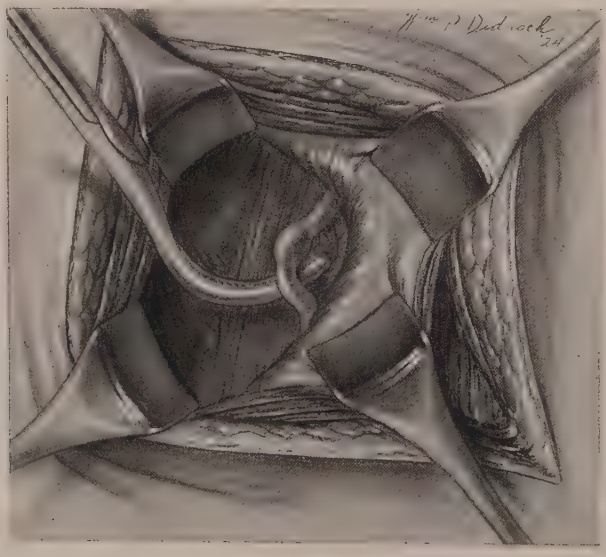


FIG. 692.—Extraperitoneal right ureterolithotomy through muscle-splitting operation at pelvic brim. Ureter is shown elevated upon curved clamp.

ease, unless, as remarked above, it may be so large and so firmly incorporated by adhesions to the posterior surface of the peritoneum (which may almost completely surround it) that it may be taken for small intestine palpated through the peritoneum.

After the ureter has been separated, it is well to put a cotton tape around it, and to proceed to free it up and down so that the required operative procedures may be carried out. The ureter can usually be drawn up fairly close to the skin surface. Through the technic above described, one is able to explore quite satisfactorily the entire lower portion of the ureter down to the juxtavesical portion. In the female the ureter will be found to pass beneath the broad ligament, the tubes, and the uterine vessels. Inflammatory and other pathologic conditions in this region may greatly interfere with an attack upon the ureter itself. In the male the ureter may come into apposition with the seminal vesicle, and occasionally may be bound up in adhesions due to a perivesiculitis. Before joining the bladder the ureter is crossed anteriorly by the vas deferens (Fig. 693) which winds around the wall of the bladder and passes in front of and to the inner side of the seminal vesicle before forming the ampulla, and reaching its terminal portion in the ejaculatory duct. The vas deferens, ureter, seminal vesicles, and posterior wall of the bladder may be bound up in pronounced adhesions which may make it impossible to expose or excise the juxtavesical portion of the ureter.

Fig. 693.—Anatomic dissection showing relation of the left ureter to vas and seminal vesicle at juncture with bladder. (Only one-half of posterior surface of bladder and prostate shown.)

In locating the ureter at the pelvic brim, the following procedure is sometimes valuable: Place the thumb upon the external iliac, then follow downward with the finger until the iliac vein is located. Passing the finger along the pelvic wall below this point the ureter can usually be discovered within 2 to 4 cm. from the median line, elevated upon the peritoneum. Hunner[1] states that one may be guided at this point by finding a small artery that goes from the internal or the common iliac, but we have never detected this artery in freeing the lower ureter, and hemorrhage encountered from blunt dissection of the ureter has never been pronounced. In the female much care must be taken in the deeper portions of the pelvic ureter not to injure the important blood-vessels of the broad ligament.

Closure is shown in Fig. 694.

Transperitoneal Exposure of the Ureter.—Although in almost all cases the ureter should be attacked through an extraperitoneal operation, during abdominal operations one may wish to locate or investigate one or both ureters. This is particularly true in gynecologic operations. The ureter may usually be found by locating the promontory of the sacrum, and passing outward until one finds the ureter where it dips down over the pelvic brim in the groove beside the sacral promontory. Location of the bifurcation of the iliac artery will often be of assistance, as the ureter is frequently found along the inner side of the internal iliac artery. Hunner states that in fat individuals one may locate the ureter by making a hole in the peritoneum with blunt forceps and palpating through this

[1] Modern Urology, Cabot, 1924, ii, 255–342.

with the thumb and index-finger. Occasionally the peristaltic waves of the ureter are of great assistance in differentiating it from neighboring vessels, these waves being accentuated by striking the ureter with a blunt instrument. The ureter having been located intra-abdominally, careful investigation should be made before carrying out any operative procedure. Should it be necessary to open the peritoneum, it is recommended that incision through the peritoneum be at a distance from the ureter so as to preserve its sheath and blood supply. Following the ureter downward one soon comes to the ovarian vessels, which approach it from the pelvic brim, and cross in front of the ureter about the middle of the pelvis.

The ureter above the pelvic brim may be reached by transperitoneal operation through the outer surface of the lateral peritoneal fold of the colon, as previously described in the operation of transperitoneal nephrectomy. Through this incision the ureter can easily be followed to the pelvic brim, and often into the pelvis if necessary. This may occasionally be desirable when the ureter is filled by tumor growth, but we have never met with this condition. Transperitoneal operations

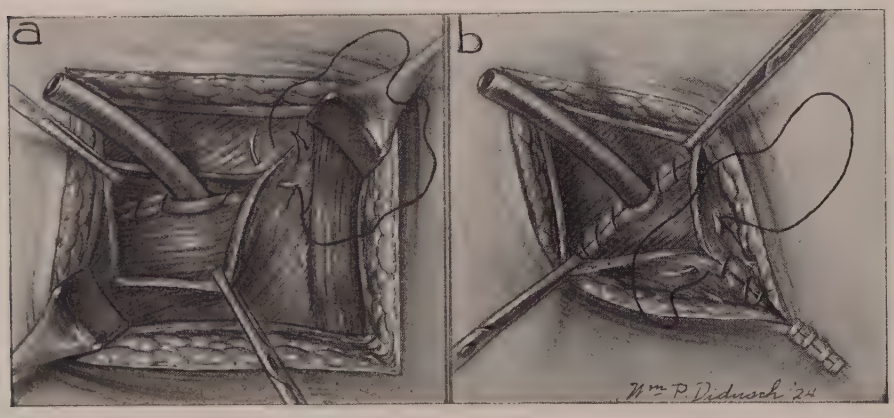


Fig. 694.—Exposure of middle and lower ureter through extraperitoneal muscle-splitting operation; closure of wound: *a*, Approximation of transversalis and of internal oblique muscles, chromic catgut. *b*, Approximation of external oblique and fascia of rectus and external oblique.

upon the ureter, however, should be avoided if possible, as the extraperitoneal route furnishes by far the most satisfactory method of approach.

Other Routes of Exposure of the Ureter.—*Vaginal.*—This method is of practically no value except possibly for calculus impacted in the lower end of the ureter, which can be palpated through the vagina. With the patient in the lithotomy position, a large posterior speculum is introduced, the cervix pulled down, and incision made through the wall of the vagina to one side of the cervix. This incision should usually be made in the region in which the calculus can be felt. The wound is enlarged and the ureter freed by blunt dissection. Care should be taken not to push the calculus upward, and a tape should be placed around the ureter to prevent this occurring. The ureter is then incised upon the stone which is removed. After probing the upper and lower portions of the ureter so as to be sure that no other calculi are present, and the ureter is not strictured, the ureter and vaginal incisions are closed separately, the latter being drained.

The operation is difficult and unsatisfactory in that ureterovaginal fistulæ often occur. The extraperitoneal operation is usually the preferable one.

Rectal.—The ureter has been reached and calculus removed through the rectum by Ceci. It would only be possible in cases where the stone was large and easily palpated per rectum. The procedure has of course been entirely discarded.

Perineal.—This method was first employed by Fenwick and recently another case in which a calculus was removed by this route was reported by Lowsley. This operation is only applicable to calculi in the juxtavesical portion of the ureter, and is quite deep and difficult. The exposure is carried out after the well-known principles of perineal prostatectomy or seminal vesiculectomy, described elsewhere. After pushing back the rectum and penetrating the space between the anterior and posterior layers of Denonvilliers' fascia, the posterior surface of the seminal vesicles is freed, and the vas deferens followed as it courses up around the ureter. The stone is palpated in this region, and by blunt dissection, the tissues are freed, the ureter incised, and the stone removed, after which the ureter is closed.

Parasacral.—In 1891 Pierre Delbet reported a case in which he reached the ureter in the following manner: Patient is placed upon the sound side. An L-shaped incision is made, of which the long branch follows the border of the coccyx and the short branch is parallel to the fibers of the gluteus maximus. The insertions of the gluteus maximus and of the sacrosciatic ligaments are sectioned. Following the lateral surface of the rectum one pushes aside the vessels and arrives at the ureter which is masked by the peritoneum. Separating this it is possible to follow the ureter for a distance of 7 or 8 cm. above the bladder. Rigby is reported to have practised this operation five times upon cases of calculus of the ureter, but 2 of the patients had fistulæ of long standing. This operation is difficult, deep, and not very satisfactory.

Paravesical Route, Anterior.—This method of approach to the lower end of the ureter was practised by us[1] in 1900 in a case of calculus impacted at the lower end of the ureter, with stricture beneath it in the intramural portion. After exposing the ureter through an extraperitoneal incision, the stone was successfully pushed upward, the ureter incised at the pelvic brim, and the stone removed. A probe passed down the ureter showed a stricture in the intramural portion, and being unable to dilate it from above, we were able to expose it through an extraperitoneal incision along the left lateral wall of the bladder. In order to accomplish this it was only necessary to draw the rectus muscle toward the median line, push the vas deferens, which was found coursing along the lateral wall of the bladder, to one side, pick up the bladder with forceps and incise it, insert retractors, and empty the bladder of its fluid, in order to obtain a view of the lower end of the ureter. A stricture surrounding the end of the probe was discovered and divided intravesically, after which the bladder was closed, the ureterotomy wound closed at the pelvic brim, and the abdominal wound closed with drainage.

This case showed the possibility of exposing the lower end of the ureter through an incision parallel to the groin, or along the outer border of the rectus muscle. After penetrating the skin and fascia of the abdominal muscles, the peritoneum is pushed backward, exposing the lateral wall of the bladder. It may be necessary to divide some of the blood-vessels supplying the bladder wall in order to expose the lower end of the ureter. In so doing, it is often helpful to follow the vas deferens as it courses around the bladder wall, and passes between the ureter and bladder before reaching the site of the seminal vesicles. This method has been em-

[1] Young: Annals of Surgery, 1903, xxxvii, 668–710.

ployed by several American surgeons in reaching calculi located in the terminal portion of the ureter, and also in exposing the ureter retrovesically and extraperitoneally before carrying out extensive operations for carcinoma of the bladder.

The steps necessary to expose the juxtavesical ureter by a paravesical route are shown in a recent case.

B. U. I. 6364, October 2, 1917, age nineteen, single. Complaint, swelling of the left scrotum, onset ten months before admission. The swelling had ruptured three weeks previously, since

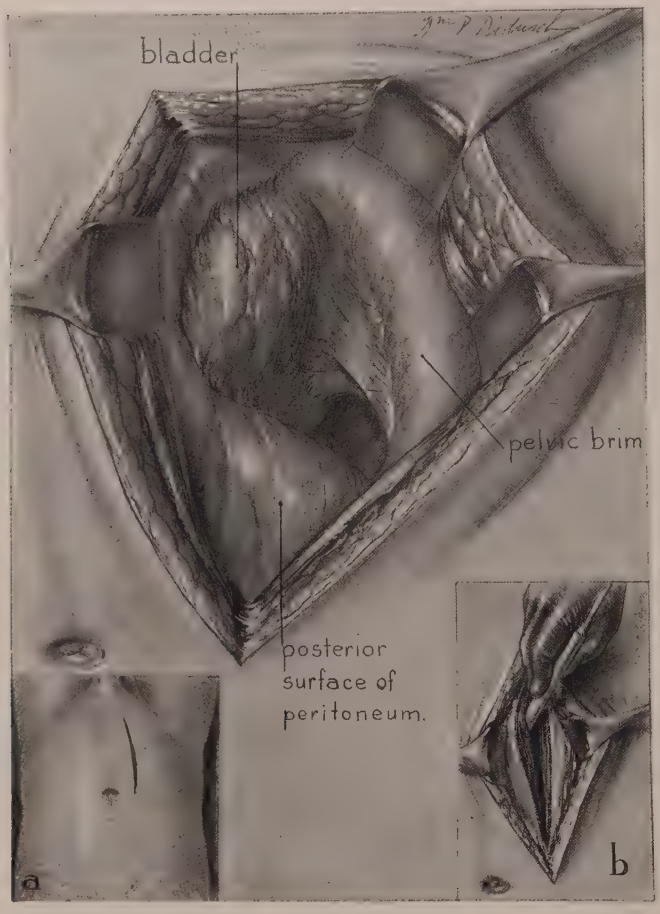


FIG. 695.—Removal of calculus from lower end of pelvic ureter: *a*, Incision near outer edge of right rectus through skin, fascia, and rectus muscle. *b*, Wound enlarged laterally by retraction. Peritoneum stripped up from lateral abdominal muscles and right side of bladder, exposing lateral ligaments of bladder, behind and to the inner side of which the ureter is found. B. U. I. 6364.

which time a fistula had been present. There had been pain on urination for ten days, and some loss of weight. A chronic cough had been present for one year. Examination showed enlargement and induration of the left epididymis with a sinus to the skin surface. The vas was enlarged. Right side of scrotum negative. Both vesicles and both lobes of the prostate were enlarged and indurated. The urine showed pus and bacilli, both acid fast and other varieties. Phthalein: Appearance time ten minutes, first hour, 30 per cent.; second hour, 5 per cent. Cystoscopy showed a cystitis without ulceration. Ureter catheterization; increased quantity of phthalein from right kidney, only a trace from the left. Left nephrectomy, October 15, 1917. Bilateral epididymectomy and resection of portion of right testis December 19, 1917. An abscess in the groin developed, which was incised two or three months later. Patient recovered from these opera-

tions, returned to work, and felt quite well except for his chronic cough which persisted. March 2, 1922 he was examined and note was made that the condition of the seminal vesicles and prostate as felt per rectum was much improved. One year later, however, he was seized with pain in the right side and became rapidly very ill. On admission to the hospital it was found that he had passed no urine since the beginning of the pain. The bladder was found empty and the *x*-ray showed a shadow in the course of the lower right ureter. A ureteral catheter was successfully passed by the stone and left in place. The urine drained through this catheter for three days and patient improved very markedly, the blood urea dropping almost to normal. The urine contained pus and was infected. Catheter was then withdrawn and a small amount of urine was

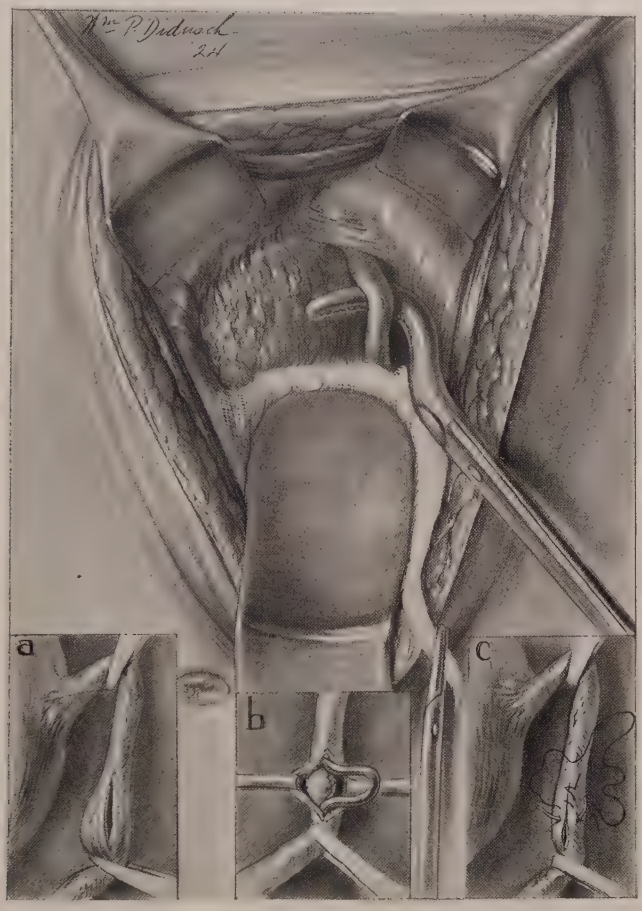


FIG. 696.—Calculus of lower portion of right ureter. Right rectus incision. Extraperitoneal retrovesical exposure of ureter, held up on goose-neck clamp: *a*, Ureter freed and held up by strips of gauze, incised over stone. *b*, Ureteral catheter, previously placed, found on top of stone and drawn to one side. Stone then removed. *c*, Closure of ureter with fine chromic catgut continuous, not penetrating mucosa. B. U. I. 6364.

passed but patient became worse again and it was evident that the obstruction was still present. Blood urea began to rise. Operation was therefore decided upon. Ureterolithotomy was performed under spinal anesthesia. An unusual method of approach was utilized in that a right rectus incision was made. Upon reaching the peritoneum, however, it was not opened but drawn toward the midline and the dissection continued down on the right side of the bladder into the pelvis, as shown in Fig. 695. The lateral wall of the bladder was exposed without difficulty and the lateral ligaments of the bladder appeared in the depths of the wound. Just below these and lying along the pelvic fascia was found the ureter. It was dissected free and the stone could be palpated at a point very close to the juncture of the ureter and bladder. After some

manipulation it was possible to bring up the ureter on a tape and make incision directly over the stone as shown in Fig. 696. The presence of a ureteral catheter which had been placed in the ureter before operation helped in the identification of this structure. After incising the ureter it was necessary to draw up the catheter, as shown in Fig. 696, *b*, before the stone could be removed. The wall of the ureter was thickened and fibrous. The ureterotomy was closed with non-penetrating catgut sutures. Following the operation the patient did not do well, the temperature rising and the blood urea failing to fall. Urine drained through the incision. Death occurred ten days later. Autopsy showed that the remaining kidney was grossly tuberculous and that the ureter as well contained many tubercles and was strictured at several points (Fig. 697). Thanks to these obstructions plus the calculus the pelvis was dilated and there was a tuberculous pyonephrosis. The ureter was strictured below the incision. The wound tract had become infected. The lungs were also tuberculous and all the organs showed fresh miliary tubercles.

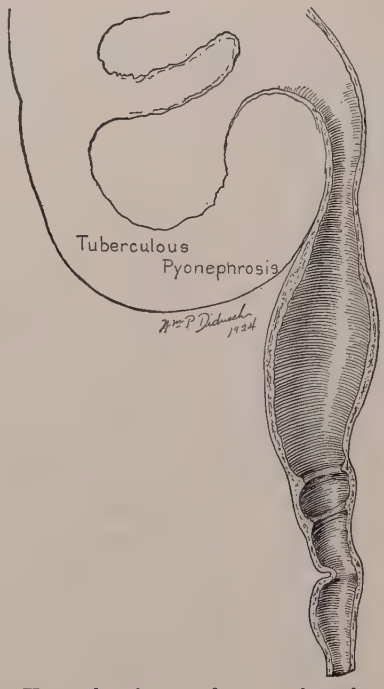


Fig. 697.—Autopsy specimen. Ureteral strictures due to tuberculous ureteritis. Tuberculous pyonephrosis above. B. U. I. 6364.

Remark.—This case is interesting from two points of view: (1) The development of tuberculosis in a kidney apparently healthy at the time of the first nephrectomy. We feel that this patient's chances would have been improved had the tuberculous seminal vesicles been removed at the time the epididymectomy was done. (2) The development of the calculous anuria as a complication. The incision adopted in this case proved quite satisfactory and gave a splendid exposure of the lowermost part of the ureter. The operative technic, however, was considerably more difficult than when the usual inguinal incision was employed.

Transvesical. (*a*) *Suprapubic:* The lower end of the ureter may be reached through a suprapubic transvesical incision and operations for calculi, strictures, balloonings, and other conditions carried out (Fig. 698).

(*b*) The lower end of the ureter may be reached by a *vaginal* incision in which the bladder is opened through the vagina and calculi removed from the lower end of the ureter. The objections to vaginal operations upon the bladder is the danger

of vesicovaginal fistula, a condition much more difficult to deal with than a suprapubic fistula, which generally heals spontaneously.

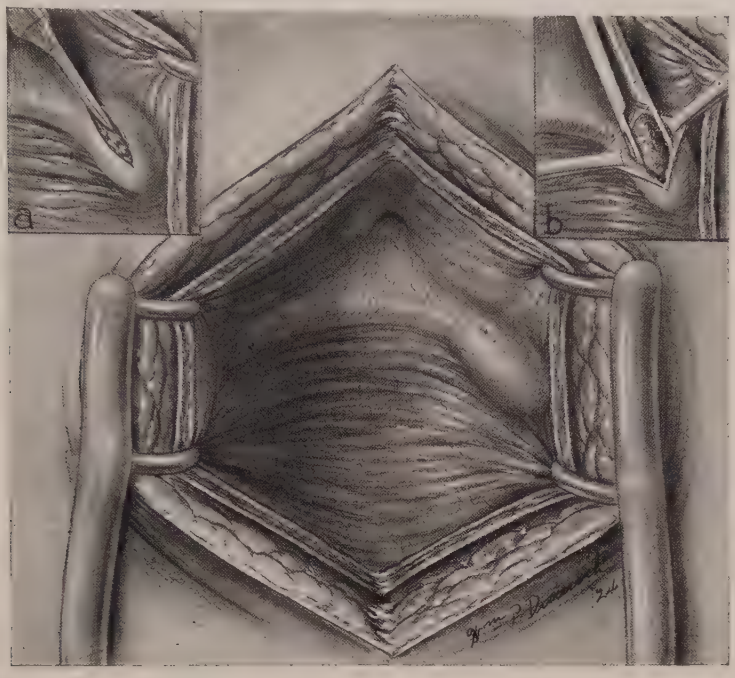


FIG. 698.—Intravesical ureterolithotomy. Removal of calculus from intravesical portion of ureter: *a*, Incision of vesical mucosa over stone; *b*, removal of stone.

(*c*) The ureteral orifice may also be reached through the *perineum*. In 2 cases of perineal prostatectomy we removed calculi from the lower end of the ureter.

Intravesical Route.—The lower end of the ureter has been reached for operations by means of cystoscopic and endoscopic instruments of various types. The

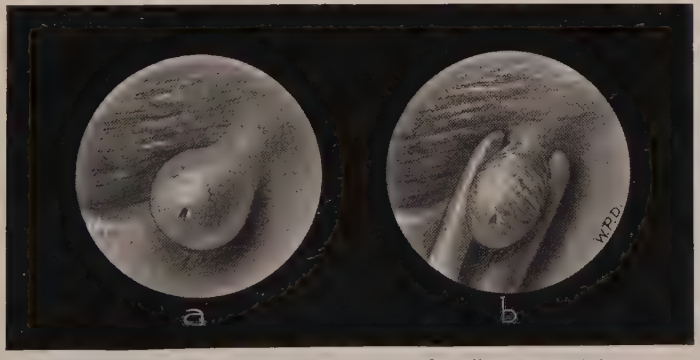


FIG. 699.—Intravesical ureteral calculus (*a*). Intravesical balloon containing stone grasped with cystoscopic rongeur preparatory to removal (*b*).

first case of intravesical cystoscopic extraction of a calculus is apparently that reported by us[1] in 1902. Various instruments for this purpose have been promulgated and numerous remarkable cures have been obtained. The methods

[1] Young: American Medicine, 1902, iv, 207–217.

are particularly valuable in the treatment of stricture and impacted calculi. Many stones incredibly large have passed following ureteral instrumentation. In 1909 we employed the cystoscopic rongeur to remove a cyst of the lower end of the ureter. E. Harnagel[1] has recently reported a case of a woman in which a calculus, impacted in the lower end of the ureter and projecting into the bladder, was caught with our cystoscopic rongeur (Fig. 699), and then drawn out through the urethra and amputated externally. The stone and its covering of mucous membrane representing the intravesical portion of the ureter were thus removed intact. Fulguration has been used to open the ureter and allow impacted calculi to pass into the bladder.

URETEROTOMY

When the ureter has been exposed by any of the methods above described, if it is impossible by simple inspection or palpation to get sufficient data, ureterotomy and sounding may be necessary. The ureter is brought up into the wound upon a tape, and a site most favorable for examination and subsequent operative procedure is selected. The incision should always be longitudinal, and is best made upon the ureter held up on the finger or some blunt instrument. Carefully incising the various coats of the ureter, no difficulty is experienced in detecting the interior of the mucous membrane and avoiding further unnecessary injury. A flexible spiral probe of proper dimensions is of great value in probing the ureter but catheters or bougies and sounds of various materials may be employed to detect strictures, calculi, diverticula, etc.

The position of the obstruction should be carefully noted, and by measuring the distance of the ureterotomy wound from the pelvis of the kidney and deducting that from 30 cm., which is the average length of the ureter, the depth to which the probe or catheter has passed below can easily be determined. This is important in estimating whether the instrument has passed out into the bladder. With a metal instrument crepitus can be easily detected, but if one is uncertain, it may often be wise to free the ureter, and by following with the finger to the point of obstruction and by palpation, to determine whether a calculus, stricture, kink, or other obstruction is present. It is always well to explore upward toward the kidney in order to make the examination complete and, in case of a calculus, to search for other stones. A wax-tip bougie may be used.

In closing the ureterotomy wound, we usually employ very fine chromic catgut sutures which do not penetrate the mucous membrane, and draw the edges of the wound into good apposition (Fig. 700). If the ureter is strictured at the point of ureterotomy or the production of a stricture is feared after a longitudinal line of sutures, it may be well to close transversely according to the Heinecke plan, thus transforming the incision into a transverse line of suture and considerably enlarging the lumen (Fig. 701). We have done this in some cases, particularly at the ureteropelvic juncture.

Ureterotomy for Stricture.—Strictures of the ureter are now generally attacked by means of cystoscopes or endoscopes with appropriate catheters or bougies. In such cases it is usually possible to dilate the stricture or (if at the orifice) to divide it with incisors or scissors, introduced either through an open endoscope or a cystoscope. Fulguration has also been employed for this purpose.[2] Where the stricture

[1] Journal of Urology, 1923, x, 141–147.

[2] Young: Journal of Urology, 1918, ii, 35–38; 1922, vii, 161–163.

is located in the ureter above the bladder, it may be attacked through the appropriate extraperitoneal operation, as previously outlined. When the stricture is due to adhesions, separation of these may release the ureter and cure the stricture at once. In the female these are frequently present in the region of the broad ligament, but they may also occur higher up in the pelvis or even along the upper course of the ureter as a result of chronic inflammatory disease. In the male they may be found at the point at which the vas deferens, ureter, and seminal vesicle join each other. The earliest case of this type was reported by us[1] in 1904. In this case, owing to the great depth of the stricture, its impermeable character, and the condition of pyonephrosis and pyo-ureter above, it was necessary to do ureterectomy along with nephrectomy.

In a more recent case (1920) a tight stricture of the ureter was found about 1 cm. above the bladder, which was apparently produced by encircling adhesions

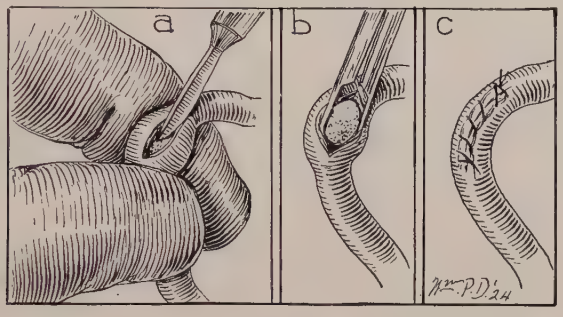


Fig. 700.—Ureterolithotomy: *c*, Closure without puncture of mucous membrane.

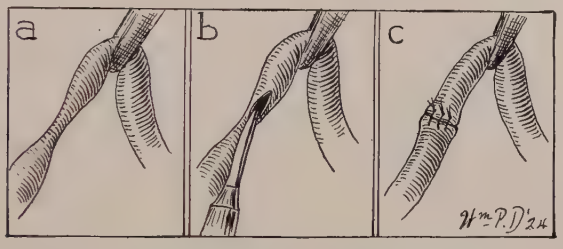


Fig. 701.—Stricture of ureter: *a*, Plastic operation; *b*, longitudinal incision through strictured area; *c*, transverse closure with fine chromic catgut.

from the tip of the seminal vesicle. Our first case is referred to in a recent paper by Mark[2] on the subject, in which 3 additional cases of stricture of the ureter in the male, due to seminal vesiculitis, are cited.

Where, at operation, the stricture cannot be relieved by the removal of adhesions, but is, in fact, an organic stricture of the ureter, one must consider either operating upon the stricture itself or opening the ureter at a point above or below, to dilate the stricture from within. If the ureter above the point of stricture is dilated, it may be easily incised, and instruments introduced to dilate the stricture. If the stricture is linear in character, and easily dilated, this may be all that is necessary. In some cases the stricture is found to be due to a valve-like fold of mucous membrane or to a kink in the ureter, which may be relieved by removal of

[1] Young: Annales des Maladies des Organes Génito-Urinaires, 1904, xxii, 1–20.

[2] Mark and Hoffmann: Journal of Urology, 1922, viii, 89–98 (Lit.).

the adhesions. In other cases it may be desirable to operate directly upon the stricture itself. The incision should be longitudinal and should completely divide the stricture (Fig. 701, *b*). After investigating the lumen above and below, the wound is then closed transversely (Heinecke) as previously described. If the stricture is extensive and characterized by a large amount of fibrous tissue with marked thickening of the ureter for a considerable distance, ureterectomy and plastic operations may be considered. These are described later on.

URETEROLITHOTOMY

This is employed in ureteral calculus when unsuccessful efforts have been made with bougies to facilitate the passage of the calculus through the ureter. The removal of the stone will depend on its location, size, character, surface, and accessibility.

As described above, the ureter will have been exposed either through an operation upon the kidney or a wound intended only for exposure of the ureter. After the ureter has been freed and drawn into the wound, the stone is located, if possible, by palpation, the ureter being sufficiently freed for so doing. If the calculus lies in the part of the ureter which may easily be reached, the ureterotomy is done directly upon the stone (Fig. 700), the incision being sufficiently long to allow removal of the stone without undue traumatism of the mucous membrane of the ureter. The operator then proceeds to investigate the ureter above and below and searches for other calculi, strictures, kinks, etc., not closing the ureter until sure that free passage above and below exists. The closure is carried out as previously described with fine chromic catgut. It is wise not to place a gauze drain down to the point of suture, but a small rubber tube leading to within an inch of (but not to) the ureterotomy wound is advisable. Urinary leakage occurs in a large majority of cases, but it generally ceases spontaneously. In our experience there has been only 1 case in which a definite stricture has followed at the site of a ureterotomy wound for stone.

Where the stone does not lie at a point in the ureter most propitious for ureterotomy and subsequent closure, efforts should be made to push the stone up or down in the ureter as may be best suited for ureterotomy. This is particularly true when a calculus is found in the deeper portions of the ureter, especially when within the pelvic or juxtavesical portions of the ureter. As the stone can usually not be seen in such cases, the operation has to be carried out by touch. The ureter is often surrounded by firm adhesions in the pelvis, and these must be carefully freed. If there is a point of stricture above it, it may be impossible to dislodge the stone, and one may have to enlarge the abdominal wound until an adequate exposure of the ureter is obtained so that one may operate directly upon the calculus; incising and removing the stone, and closing if possible. If, however, it is impossible to close the ureter, one need not fear persistent urinary fistula unless there be a stricture below. This is easily made out by passage of bougies into the bladder. If the subsequent urinary sinus is slow in healing, ureteral catheterization and dilation with bougies may be carried out to relieve any constriction and facilitate the closure of the wound.

In most cases of calculi of the deep ureter, it is possible to push them upward by a milking process between the thumb and finger. As these calculi are often rough and even spiculated, it is very important that pressure should not be made

through the ureteral wall directly upon the calculus, but beneath the calculus so as to push it up and prevent the spicules becoming embedded in the mucous membrane. In some cases great difficulty is experienced in dislodging the calculus, and it may even be impossible to move it. In such cases we have attempted by means of a long probe bent in the form of an open loop to surround the ureter with the loop below the point of the stone, and to draw it upward until the stone has been brought to the point where it can be removed. In some cases, however, all efforts to dislodge the stone upward from the deep ureter fail, and it is then advisable to introduce long ureteral stone forceps and to grasp the stone within the ureter if possible. Before doing this it is well to measure carefully the length of the forceps blade, and make incision sufficiently low in the ureter so that the instrument will reach it without being introduced beyond the joint. In grasping the stone with such forceps, much assistance can be had by placing a finger beneath the stone in the depths of the pelvis. The forceps should be not only very delicate and flexible, but the terminal portions of the blades should flare outward slightly, so as to facilitate the grasping the calculus, and also to prevent catching the mucous membrane.

The progress of the surgery of stone in the lower ureter has been very rapid in the last twenty years. In 1902 we collected all the cases in the literature and with two of our own were only able to present 9 cases in which calculi had been removed from the lower end of the ureter just above the bladder in the male.[1]

At that time many surgeons held the extraperitoneal route entirely inadequate, and were advocating such procedures as sacral, parasacral, perirectal, rectal, peritoneal, or vaginal routes. Since then the great advantage of the extraperitoneal abdominal route has been proved, and now the inferior routes are rarely, if ever, employed. In our opinion the methods just described are the most satisfactory for stones impacted even in the juxtavesical portion of the ureter. Although apparently the first to employ a paravesical exposure of the lower end of the ureter, we do not believe that this is necessary either in reaching the ureter immediately behind the bladder or within the bladder for strictures, as we have found it possible to remove all calculi that we have so far attacked by the extraperitoneal abdominal methods above described.

OPERATIONS FOR TRAUMATISM OF THE URETER

The **surgery of ureteral injuries** occupies a formidable amount of space in the literature, due principally to the great number of instrumental traumatisms to the ureter during gynecologic operations. Since the advent of ureteral catheterization, and the protection afforded by having a catheter in the ureter during difficult pelvic operations, the number of cases has been greatly reduced. In many instances the ureter has been either divided, traumatized, or ligated without the fact being discovered at operation. Where both ureters have been occluded, anuria has followed promptly and demonstrated the situation for which immediate operative intervention is required. Where only one side has been occluded, the onset of acute hydronephrosis, with distention, muscle spasm, and (sometimes) infection has pointed to the ureteral occlusion. In other cases the urine has escaped into the abdomen and shown itself by an increasing collection of abdominal fluid.

[1] Young: American Medicine, 1902, iv, 209–217. Annals of Surgery: 1903, xxxvii, 668–710.

It is hardly necessary to point out the preventive measures necessary to avoid such fearful mistakes, or the importance of determining before the end of an operation whether the ureter has been injured or occluded. Cystoscopy and ureteral catheterization can be carried out so quickly that this should be done without delay to settle the question.

Where it is recognized that the ureter has been injured or divided, the operator should decide upon the methods of repair. Cases are reported in which the operator has discovered an opening into the ureter and has been able to bring the cut edges of the wound together with fine sutures without raising the ureter from its bed. Such is undoubtedly the method of choice where the ureter has only been partially divided. Where the division is complete, end-to-end anastomosis upon a ureter catheter is the most approved method. Some surgeons have introduced a short segment of ureter catheter into the two ends of the divided ureter. Interrupted sutures are then placed, but before being tied, the catheter is removed. The preferable way would seem to be the introduction of a catheter by means of a ureter catheter cystoscope through the bladder (Fig. 702). The end of the ureter catheter which escapes from the cut end of the ureter would then be threaded into the upper end of the ureter. The advantage of this method is that the anastomosis can be done and the sutures tied while the catheter is still in place, and it may, in fact, be left there for several days after the operation for drainage of urine.

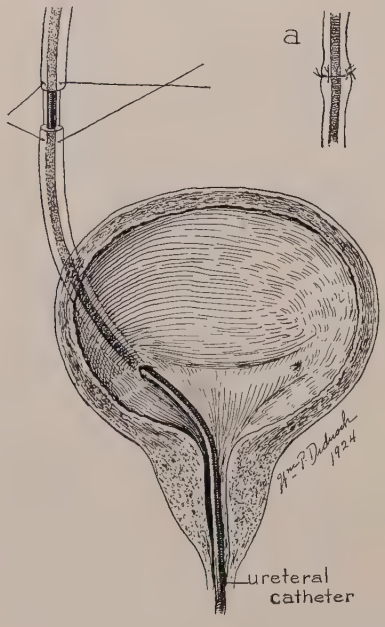


Fig. 702.—Ureteral anastomosis around a catheter passed by cystoscopy before or during operation.

Hunner[1] quotes a method of Payne in which an end-to-end anastomosis is done by means of a straight intestinal needle which is passed through the wall of the ureter both above and below the site of division and caught with clamps which assist in immobilizing the ureter during the insertion of sutures. When the sutures are tied and the anastomosis completed, the needle is then pulled out through one of the punctured wounds.

Various methods of end-to-end and lateral anastomosis have been devised, and illustrated in numerous text-books. Most of them are complicated and difficult and have not come into general usage.

Unfortunately, it is impossible in many instances to carry out anastomosis of the ureter. This is particularly true in those cases in which the ureter has been completely divided or seriously injured in the deeper portions of the pelvis. The use of an inlying ureteral catheter to be covered with peritoneum may be considered, or transplantation of the upper end of the divided ureter into the bladder. This procedure has been carried out in many instances. Numerous technical modifications have been employed. We have never had to carry out the operation

[1] Cabot's Modern Urology, 1924, ii, 255–342.

for traumatism of the ureter, but have frequently transplanted the lower portion of the ureter after it has been excised with vesical tumors. In such cases we have found that the best procedure is simply to puncture the bladder with a clamp, and draw the ureter well within it, then to fasten it there by sutures behind the bladder and also within the bladder. The cut end of the ureter which is free in the bladder cavity may be divided for a short distance so as to produce a flaring orifice, or it may be split on two sides and the split edges sewed to the bladder mucosa. It may also be simply divided obliquely and left free in the bladder (Fig. 703). The probabilities are that it matters little what is done to the ureter within the bladder. When observed through a cystoscope subsequently, one finds generally an irregular elevation in which the orifice of the ureter is seen. The remaining portions have either sloughed away or retracted, or been absorbed.

It is impossible to produce an artificial sphincter for the ureter, and one has to trust to keeping the bladder free from infection to preserve the kidney in its functional efficiency. It seems to make little difference where the ureteral anastomosis is made with the bladder. In picking a site for anastomosis much depends upon the length of the ureter. If possible, it should be done extraperitoneally, the perit-

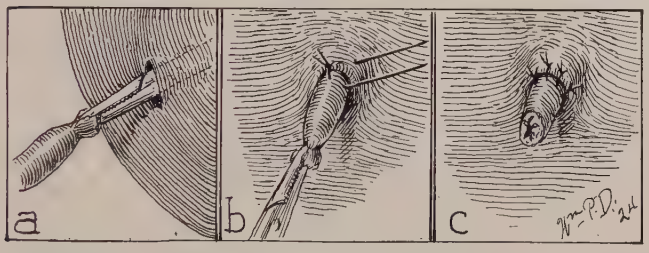


FIG. 703.—Transplantation of cut ureter into bladder: *a*, Posterior view of bladder wall through which clamp has been inserted, grasping ureter, which is then drawn into bladder. *b*, Interior view of bladder. Suture of ureter to vesical mucosa. *c*, End of ureter free in bladder, cut obliquely (or split).

oneum being carefully closed over the ureter so as to avoid pockets in which intestinal loops may become entrapped.

Anastomosis With the Intestines.—In numerous cases mentioned in the literature surgeons have seen fit to carry the cut end of the ureter into the intestine, and various ingenious procedures have been devised with the hope of preventing ascending infection which occurs in the great majority of cases in which this operation is done. Unfortunately, very little success has been obtained, and pyonephrosis results in a very large percentage of cases. Uretero-enteric anastomosis should, therefore, be abandoned, except possibly for exstrophy of the bladder. The technic is shown in the description of operations for exstrophy of the bladder.

Transplantation of the ureter for diseases of the bladder will be discussed elsewhere.

URETERECTOMY

Primary Ureterectomy.—This may be either partial or total. The operation is rarely done except in cases of tuberculosis, pyoureter, or cancer. In tuberculosis, even though the ureter may be diseased, it is usually not wise to excise it. In the first place, it is extremely difficult to excise all of it, and it is usually safer to keep the disease confined within the fibrous tube, where it may be treated with phenol at operation and subsequently. If desirable it may be drained through the wound

with a rubber tube which is telescoped over its upper end. The stump may be treated with a ureter catheter subsequently, should this seem desirable to cure suppuration (pyo-ureter) or hasten closure of the ureteral fistula.

In cases in which nephrectomy is to be carried out for tuberculosis, if the ureter is found to be very greatly enlarged and badly diseased, it is sometimes desirable to remove the ureter as completely as possible. Where the adhesions in the deeper portions of the pelvis are very great and difficult to free, partial ureterectomy may be all that is possible. In such a case the stump should be thoroughly cauterized, ligated, and then drained with a rubber tube, which, if possible, should include the end of the stump. In carrying out this procedure, great care should be taken not to penetrate the peritoneal cavity for fear of tuberculous peritonitis. As stated elsewhere, total ureterectomy may be done either through the original incision prolonged downward toward the suprapubic region, thus producing a wound 12 or 14 inches in length (Fig. 674), or by making the secondary muscle-splitting wound in the lower abdomen (Figs. 687–694) and removing the lower portion of the ureter through this. This wound should be made large enough so that the kidney can be drawn out through it, high division of the ureter being thus avoided (Fig. 675), and the kidney and ureter removed in one piece.

In 1 case in which we carried out this operation an extensive tuberculosis of the deep wound resulted, and the patient died of miliary tuberculosis. In other cases, however, very satisfactory results were obtained. The operation, undoubtedly, removes a large tuberculous tract, and probably avoids a chronic tuberculous sinus.

In tumors of the kidney, particularly those of the renal pelvis, which extend well down into the ureter, partial or complete ureterectomy may be desirable. In some such cases a prolongation of the tumor has been found projecting through the ureteral orifice into the bladder, being withdrawn at operation.

Total ureterectomy may also be desirable in cases of pyoureter, and if so, the technic and indications already described are applicable. It may be said, however, that with the removal of the obstruction in cases of ureteral stricture, or after nephrectomy, a markedly dilated ureter may contract down to a mere cord, and is not likely to give much inconvenience. It is certainly true that ureterectomy is an operation which should be carried out with hesitation, because even though the ureter may be considerably diseased, even markedly tuberculous, after nephrectomy the regenerative processes which set in are sufficient to take care of the pathologic conditions present, and give a good operative result. Total ureterectomy is an extensive, tedious, and difficult operation, and should be carried out only in rare instances.

Secondary Ureterectomy.—The ureter left behind at nephrectomy may in rare instances give sufficient trouble to warrant a secondary operation for its complete removal. This happens occasionally in tuberculosis, and also in pyoureter, particularly where there is a stricture, valve formation or stone in the lower portion. In some cases in which the vesical end of the ureter is patent, a urinary fistula in the loin may require ureterectomy for its cure. The operation is best carried out by means of an incision away from the previous site of operation, and generally through the lower portion of the abdominal wall, by means of the muscle-splitting extraperitoneal operation, which has been described elsewhere. Exposing the ureter above the pelvic brim, one follows it upward until the upper end is

freed and brought out of the wound. The lower portion of the ureter is then mobilized, every attempt being made to break up adhesions, and follow the ureter to its very juxtavesical end. The interior is then cauterized by carbolic, a ligature placed, the ureter divided, and the upper portion removed. Tube drainage to the stump is indicated, and it may be desirable to place the patient on his abdomen to secure proper drainage. In case the wound becomes tuberculous, and in order to avoid a miliary tuberculosis it should be opened widely and treated vigorously so as to save the life of the patient. It may be reiterated that, even if extensively tuberculous, the ureter may usually be left behind, especially if treated with carbolic at operation, and that we may expect no further trouble with the ureter and a complete disappearance of the tuberculous process in the ureter and also in the bladder below.

OPERATIONS ON FISTULÆ OF THE URETER

The character of fistulæ of the ureter depends largely on their etiology. Those in the loin are generally postoperative, but they may occur following spontaneous

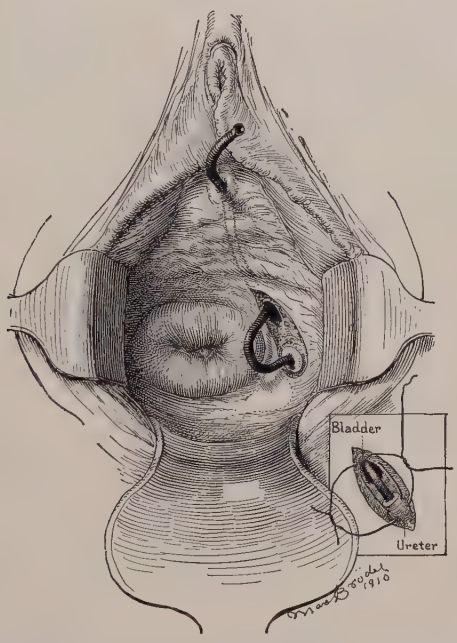


Fig. 704.—Ureterovaginal fistula. The larger figure shows a ureteral catheter which has been introduced through the urethra and brought out through an incision into the bladder in front of ureterovaginal fistula. It is then passed up into the ureter. The end of ureter is then drawn by sutures downward and transplanted into the bladder as shown in the smaller figure. Kelly-Burnam.

evacuation of pus from the kidney (perinephric abscess), or after traumatism, gunshot, and stab wounds, etc. If the kidney is present, urine may escape from the fistulous tract, and this may occur also when the kidney has been removed. In such cases the urine regurgitates from the bladder through the ureter, and out the fistulous opening. Ureteral fistulæ also occur at the site of ureterotomy wounds for strictures and calculus. They are also found in the vagina, and sometimes the rectum, as a result of gynecologic operations or injuries at childbirth. Pelvic abscess may also be present. The operative treatment depends in a large degree whether the discharge is urinary or seropurulent. The latter cases can be usually

cured by curettage and antiseptic treatment. Such treatment can be applied to the ureter from without, or by means of ureter catheterization. Dilatation of the ureter will often cure stricture or a valve-like condition which may be present, and hasten the closure of the fistula. The operative treatment depends entirely upon the conditions present. Where there is a badly suppurative kidney, nephrectomy and partial ureterectomy may be required. If calculi are present in the kidney or in the ureter, these should be removed, and this may lead to prompt closure of the fistula. Fistulæ following nephrectomy should be treated first by local ureteral measures, and if these fail, total or partial ureterectomy. It may be possible in rare instances to excise the fistulous tract leading to an opening in the ureter, and to close the ureter in continuity. This would seem to be indicated in cases where a fairly healthy kidney was present above the point of fistula. In

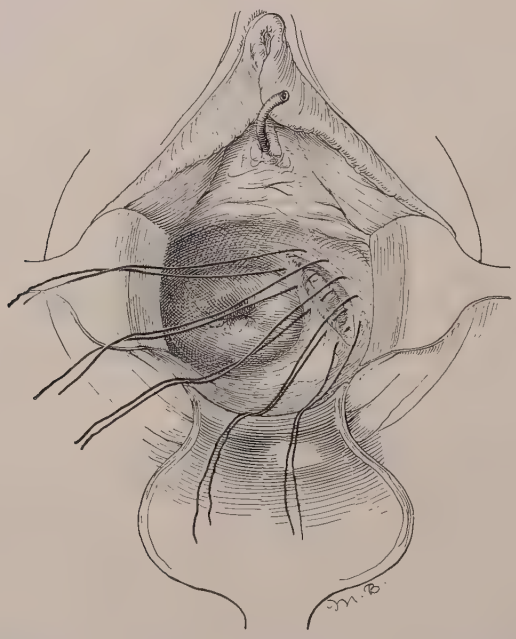


Fig. 705.—Ureterovaginal fistula. Closure of the vaginal wall over the transplanted ureter. Ureteral catheter left in place several days for drainage. Kelly-Burnam.

most cases, however, we believe that inflammatory conditions in the lower ureter, strictures, etc., are responsible for the persistence of the fistula, and that these cannot be cured by local measures. Nephrectomy with excision of the ureter, if necessary, should be carried out. In cases of regurgitating urinary fistula ureterectomy is usually necessary, and should be as complete as possible.

Fistulæ of the ureter which communicate with the vagina and rectum require excision and appropriate plastic closures. In carrying out the operations through the vagina one is cautioned to remember the proximity of important blood-vessels and the possibility of dangerous hemorrhage. Here again one must be sure that the ureter below the site of the fistula is patent, and capable of furnishing good drainage into the bladder. The method employed by Kelly is shown in Figs. 704 and 705. In some cases it may be wise to carry out nephrectomy in cases of ureteral fistula, regardless of their location.

CHAPTER XVI

OPERATIONS ON THE BLADDER

SUPRAPUBIC CYSTOTOMY OR CYSTOSTOMY

This operation may be done under local, spinal, or general anesthesia, preferably gas and oxygen.

The bladder lies in the pelvis and in a distended state rises above the symphysis pubis. It can be reached by an incision through the hypogastric region extraperitoneally.

The patient lies upon his back, preferably upon a table in which the Trendelenburg position can be secured. At our clinic we use a special urologic table in

Fig. 706.—Young's urologic table in Trendelenburg position. Legs of patient separated by side bars and leg supports allowing rectal or vaginal procedures or a place for an assistant to stand between the thighs. This position may be used for air cystoscopy, the head being even more depressed until the bladder fills with air by negative pressure.

which the patient's knees are flexed and held in position by crutches, as shown in Figs. 202, 706. The advantage of the table in this operation is that the thighs are widely separated and space is thus provided for the operator or his assistant to stand between them and carry out any procedures that may be desirable (*e. g.*, catheterization, vaginal or rectal manipulation, etc.). The operation is begun with the patient horizontal, but when the bladder is reached it is generally wise to depress the head of the patient into the Trendelenburg position. This causes the pelvic intestines to fall toward the diaphragm, and allows the bladder to be retracted and held open with greater ease.

The preferable incision is the median, the lower angle being at the upper border of the symphysis pubis and from there extending upward a variable distance, de-

FIG. 707.—Suprapubic cystotomy. Median line incision. The skin, fat, and rectus fascia have been incised, the recti muscles are being dissected bluntly.

FIG. 708.—Suprapubic cystotomy. The bladder has been stripped of its prevesical fascia and fat. The peritoneum is being pushed up with gauze. Note blood-vessels in muscular wall of bladder.

pending upon the extent of the operation to be carried out. For simple exposure of the bladder in a fairly thin patient, an incision 3 cm. in length ($1\frac{1}{2}$ inch) is usually sufficient. After passing through the skin, subcutaneous fat, and fascia, one reaches the deep fascia covering the recti muscles. A longitudinal incision through this in the median line will open up the space between the two recti muscles. As a rule, these muscles lie closely approximated so it may be difficult to see their respective borders, but by blunt dissection with the handle of a scalpel, the line of cleavage can be found, and with a to-and fro motion up and down the median

Fig. 709.—Suprapubic cystotomy. The bladder is caught up with Allis clamps and incised between them. Peritoneum held up by gauze pad under retractor.

line, the space between them can be widely separated (Fig. 707). If the bladder is distended, one will find it beneath the lower part of the wound. Beneath the upper part of the wound is the peritoneum with the transversalis fascia covering it.

Previous to operation it is wise to have the bladder fully distended. In individuals with complete retention of urine this condition is already present, and it is unnecessary to pass a catheter to fill the bladder. In cases where the bladder is empty or only partly distended, it is wise to insert a catheter and fill the bladder with air preparatory to the operation.

Lateral retractors are inserted and with the finger behind the symphysis pubis the operator palpates to find the anterior surface of the bladder. He then with the finger pushes upward the fat and areolar tissue which cover the anterior wall of the bladder, on the surface of which large veins running more or less longitudinally are seen (Fig. 708). The peritoneum in some cases dips down well behind the symphysis pubis and may be found covering the anterior surface of the bladder. By blunt dissection (a strip of gauze beneath the finger is excellent) the peritoneum can usually be pushed upward so as to expose a sufficient surface of the anterior wall of the bladder for cystotomy. The bladder is then picked up

Fig. 710.—Suprapubic cystotomy. Index-finger in bladder upon which the incision is enlarged upward, care being taken to avoid peritoneum.

with clip forceps ("Allis" clamps) and a scalpel is plunged through the musculature into the cavity (Fig. 709), the opening of which is heralded by the escape of air (or water). The edges of the mucous membrane and muscle are then caught with Allis clamps on each side to hold them apart while the finger is introduced for investigation or preliminary to enlarging the wound (Fig. 710).

If one simply wishes to examine the bladder, this is done with the finger and should be systematic and comprise the prostatic orifice and region of trigone, a search for trabeculæ, diverticula, cellules, stones, ulcers, tumors, etc.

Permanent Drainage (Cystostomy).—After careful exploration of the bladder and mapping out any future surgery that is to be done, a tube is inserted to carry off

the urine. The de Pezzer self-retaining mushroom catheter, preferably with a fixed curve 3 or 4 inches from the inner end, is the instrument of choice. It is inserted by means of a stylet or clamp (Fig. 711)—which stretches out the mushroom enlargement—into the bladder and then drawn outward until it is stopped by the bulbous enlargement. If necessary, a suture is placed in the bladder to reduce the size of the wound and one may tie this around the neck of the drain to prevent its escape. It is wise also to fasten the tube by means of a stitch to the skin after which the suprapubic space is drained lightly at the lower angle with gauze. The

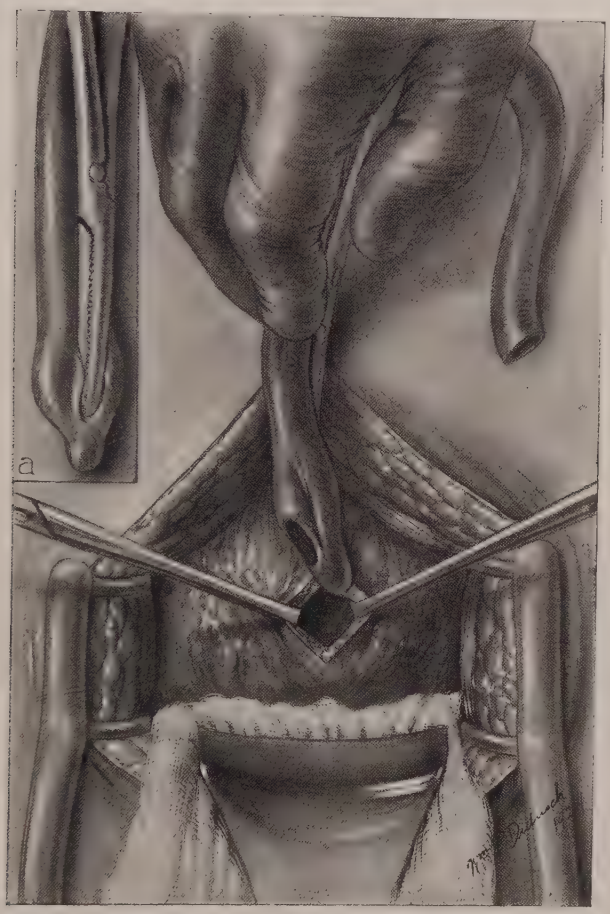


Fig. 711.—Suprapubic cystostomy for drainage. Insertion of de Pezzer drainage-tube with a long clamp which obliterates the "mushroom," *a*.

muscles and skin are drawn together above the tube with one or two stitches of silver passed through the skin, fascia, and muscles on each side and tied loosely with a rubber tube threaded upon one side (Fig. 712). Clips or sutures may be used to approximate the skin between the silver sutures.

Subsequent treatment depends much upon the case. Where the bladder has been found greatly distended with urine it is not wise to allow the bladder to empty itself completely for fear of the suppression which follows sudden relief of back-pressure upon the kidney. In such cases the drain should lead up hill over a considerable elevation. In the accurate handling of these cases it is best to use

apparatus to determine the intravesical pressure and modify day by day the elevation of the drainage-tube. This has been described in detail in discussing the treatment of prostatic hypertrophy by preliminary suprapubic drainage. Where such apparatus is not at hand one may devise simple methods by which a requisite amount of intravesical pressure is maintained until the kidney becomes accustomed to the absence of obstruction. Where the mushroom or other form of self-retaining catheter is not at hand a simple rubber tube may be used (Fig. 713). It should contain a notch and a fenestration and be introduced only far enough to obtain good drainage. The end should not impinge upon the base of the bladder and prostate, else hemorrhage and pain may result. It is important to fasten such a tube both to the bladder and also to the abdominal wall.

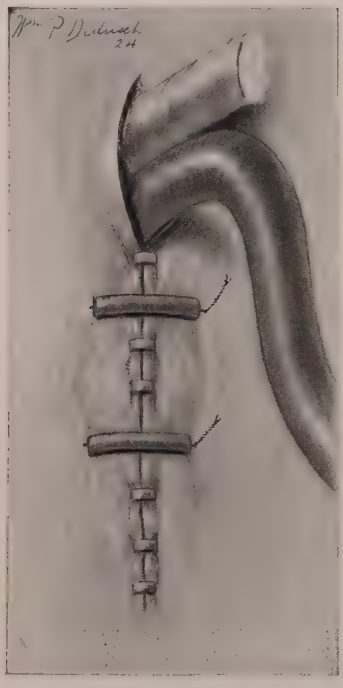


Fig. 712.—Showing muscles, fascia, and skin drawn together above drainage-tube with deep silver wire sutures, covered externally by rubber tubing. Skin closed by metal clips. Prevesical cigarette drain at lower angle.

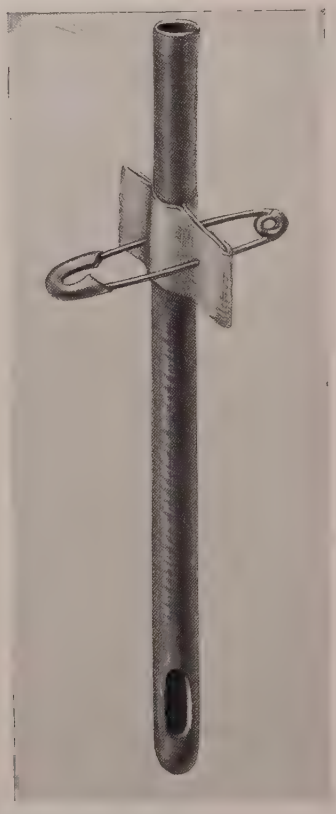


Fig. 713.—Suprapubic catheter drain armed with adhesive band and safety-pin for anchoring in place.

Subsequent treatment consists simply in removing the gauze, and allowing the wound to cicatrize around the drainage-tube, which should not usually be changed for about eight or ten days after operation, but during this time great care should be taken to prevent calcareous deposits upon the intravesical portion of the drainage-tube by means of frequent lavage of the bladder with antiseptic solutions. The use of mercurochrome has been very valuable in preventing the infections which lead to formation of mucous and the deposition of calcareous masses upon inlying drains and catheters. It is now possible to leave them in place much longer than heretofore, but the greatest care and attention are required and calculi must not be allowed to form.

After the first week or ten days the drain should be changed at intervals of from four to seven days and it may be gradually reduced in size until an appropriate tube for permanent drainage is employed. It is not wise for the bladder to become contracted and on this account, it is well for the patient to empty the bladder through the tube only at intervals. This may be done by simply tying a knot or inserting a plug within or clamp upon the tube. If desirable, some form of urine bag may be worn to catch the urine, particularly in cases where the bladder has been rendered small by serious disease and almost continuous outflow through the tube is required.

SUPRAPUBIC PUNCTURE OF THE BLADDER

Suprapubic puncture of the bladder is generally carried out with a needle about the size of a small bonnet pin (such as is used for subcutaneous infusions). The

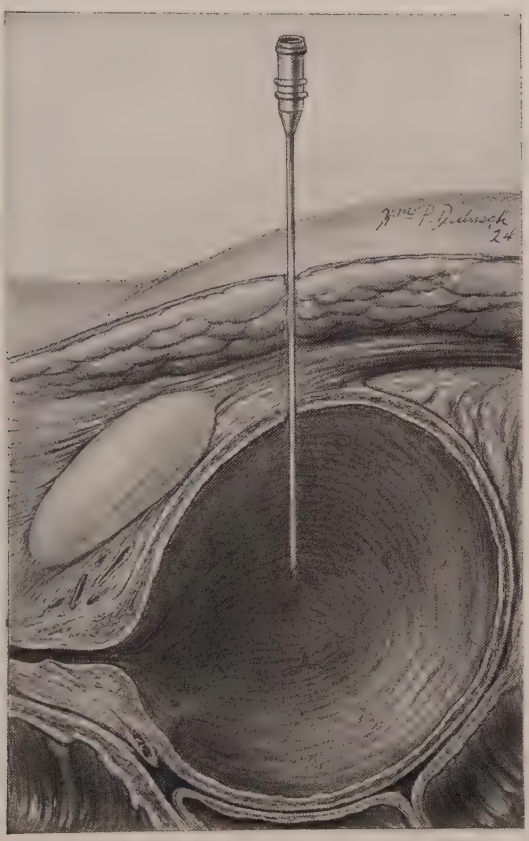


FIG. 714.—Position of needle in suprapubic puncture. It is vertical and 2 cm. from the upper border of the symphysis. If placed lower, it enters the prevesical space and may cause bleeding. If placed higher, it may wound the peritoneum.

needle, passing through the skin and muscles, should reach the bladder without touching the peritoneum. Owing to the variable distance which the peritoneum reaches in front of the bladder, it is quite important that this operation should not be carried out unless the bladder is considerably distended and can be percussed well above the symphysis pubis. Having determined the upper border of the sym-

physis, a point 1.5 cm. above it is located on the skin and the needle, held in a vertical position, is plunged through the skin, muscle, and bladder wall into the cavity (Fig. 714). The escape of urine will indicate when this has been reached. The distance varies from 2 to 3 or even 4 inches (the latter in fat individuals). It is important not to direct the point of the needle too much downward, else it may plunge into an intravesically projecting prostatic lobe. In large hypertrophies this may easily occur and it may be necessary to withdraw the needle somewhat and try a more upward direction when the operator is certain that he has reached the bladder. If the needle used is small, aspiration with a large syringe or suction apparatus greatly facilitates the process of emptying the bladder. It is wise not to use too big a needle, else escape of urine through the punctured wound in the bladder wall into the prevesical space may occur.

FIG. 715.—Insertion of rubber catheter through cannula into distended bladder suprapubically. This procedure is fraught with danger.

The operation of suprapubic puncture and evacuation is not infrequently done in cases of complete retention associated with acute gonorrheal urethritis and prostatitis or prostatic abscess. It may often be necessary to repeat the puncture several times, but if care be taken, this may be done with impunity. There is a case on record in which the bladder was thus punctured one hundred times. In these cases of acute inflammatory obstruction, natural urination may be restored by the first emptying of the bladder by suprapubic puncture, which is, therefore, much to be preferred to the passage of a urethral catheter which may cause serious traumatism in cases of acute gonorrheal prostatitis.

Vesical Puncture With Trocar and Cannula.—A procedure similar to the one just described may be carried out with a cannula of sufficient size to carry a small suprapubic drain which is to be left in place after removal of the trocar. The

puncture is made through the skin, muscles, and prevesical tissues into the bladder, as above described. The trocar is then removed and a rubber catheter passed through the cannula into the bladder (Fig. 715), and fastened in place by means of a stitch to the skin.

Catheter drainage through a cannula has, in our opinion, much to condemn it, principally owing to the variable depth to which the peritoneum extends and the danger of prevesical infection without provision for adequate escape externally. We have seen autopsies in which the trocar has penetrated a loop of intestine before reaching the bladder. We have also seen prevesical extravasation. With the open method of suprapubic cystotomy such accidents are avoided or taken care of.

SUPRAPUBIC LITHOTOMY

This operation comprises opening the bladder suprapubically for the removal of a calculus. It should be called cysto- or vesicolithotomy. It may be carried

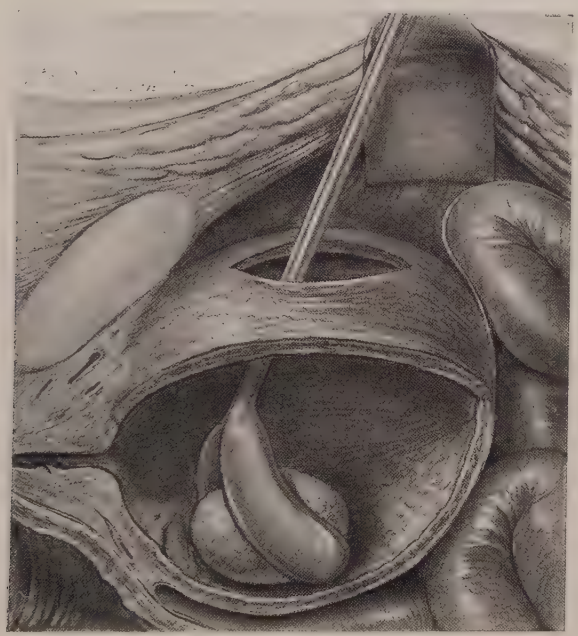


Fig. 716.—Suprapubic lithotomy. The lateral wall of the bladder is cut away to show forceps grasping stone, through cystotomy.

out under local, spinal, or general anesthesia. The position of the patient is similar to that for suprapubic cystotomy. The bladder is opened as above described unless there are special indications for different incisions. Not infrequently a fairly large opening in the bladder is required. After the preliminary incision has been made it is well to insert the finger and bend it upward toward the vertex of the bladder, which is then drawn upward upon the hooked finger. By means of a strip of gauze, one can then push the peritoneum upward until the urachus is reached.

The bladder wound may be enlarged by carefully cutting upon the finger (Fig. 710), upon a grooved director, or by means of scissors. The wound may also be enlarged toward the prostatic orifice. Through this a stone forceps is introduced for removal of the calculus.

If it is necessary to examine the interior of the bladder it is well to insert a self-retaining retractor, as shown in Fig. 718. The posterior wall of the bladder will usually then appear to bulge into the wound. By markedly depressing the head of the patient (marked Trendelenburg position) and inserting a retractor in the upper angle of the wound, the whole floor of the bladder is opened out to view. The retraction of the posterior wall of the bladder may be increased by placing beneath the retractor in the vertex of the bladder a large folded gauze sponge to which a string is attached (Mikulicz pad). A view should then be obtained sufficient to carry out almost any procedure that may be necessary within the bladder. In many cases of vesical calculi such wide exposure is entirely unnecessary.

A simple incision large enough to admit a stone forceps may be all that is required (Fig. 716). After introducing forceps a careful search is made, first, of the base and upper portions of the bladder, the operator opening the forceps and grap-

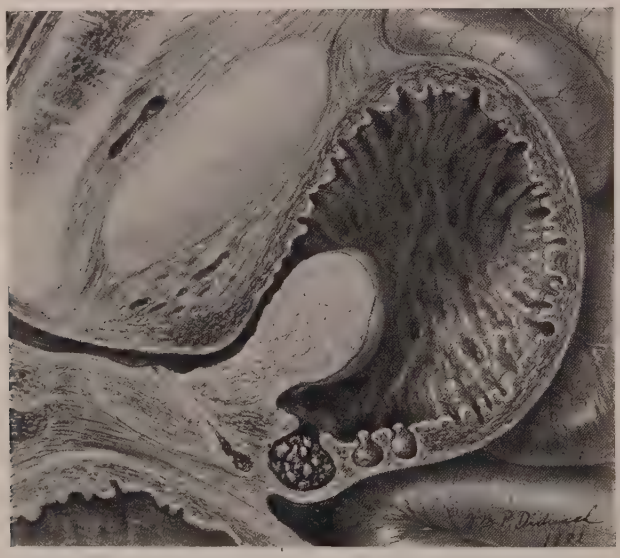


Fig. 717.—Diagrammatic section showing location of calculi in cellules behind trigone, man aged seventy-four with huge middle-lobe hypertrophy. B. U. I. 10,714.

pling for the stone. As a rule, a knowledge of the size, character, and number of calculi present will have been gained beforehand by cystoscopic examination or *x*-ray. After the stone has been grappled, an attempt is made to withdraw it through the vesical wound. If it fails to emerge this may be due to the fact that the instrument holds the stone by its longest diameter. By releasing the calculus and attempting to grapple it by another diameter, a stone may be often removed by a smaller vesical opening. A careful search should be made before the operation is considered complete, and all the calculi removed should be assembled and compared with the cystoscopic and *x*-ray reports.

Encysted calculi held within pockets, pouches, cellules, diverticula (Fig. 717), or the lumen of urachus, ureter, or prostatic urethra may be difficult to remove. The orifice connecting with the extravesical pouch is sometimes so small as to be difficult to find (Fig. 718). Occasionally it can only be discovered by probing. Sometimes incisions may be necessary to open up the cavity and remove the stone.

A portion of the calculus is often found projecting within the bladder. In such cases the stone is in the form of an hour-glass or a sheaf of wheat, the constricted portion lying within the orifice connecting the saccule with the bladder. In some cases a delicate spicule projects from the encysted stone through the diverticular orifice into the bladder. In such cases stones found loose in the bladder have previously been attached to the encysted stone. An interesting case of this type was that of a man eighty-four years of age who had undergone 17 operations for the removal of calculi from the bladder. Cystoscopic examination showed a stone 3 cm. in diameter within the bladder. When this was removed a very fine

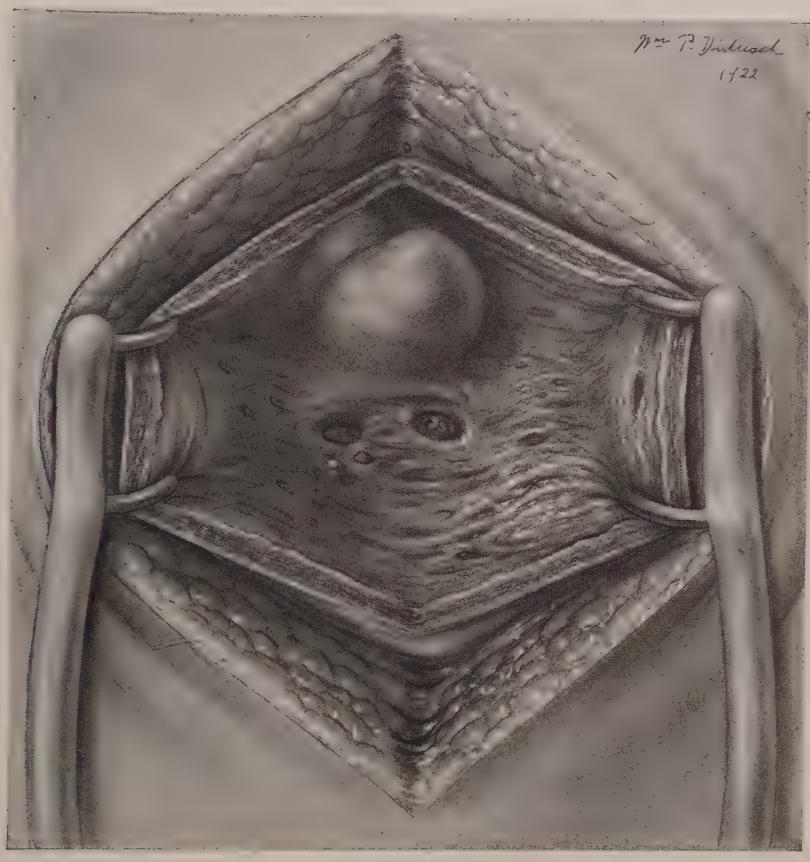


FIG. 718.—Bladder opened revealing large middle lobe. Four encysted calculi behind the trigone. B. U. I. 10,714.

stem 3 or 4 mm. in length was noticed upon its surface. Realizing that this probably connected with an encysted calculus, a most careful search was made and finally one was found within the lower portion of the urachus and from this there projected a delicate pedicle which corresponded with the spicule or pedicle found upon the calculus in the floor of the bladder. The encysted stone and the diverticulum were excised and the patient had no more calculi. The operative attack upon the encysted calculi is so variable in its nature and technic that it is difficult of description. Where the stone projects into the bladder, it may often be grasped with forceps and gradually drawn out from the extravesical cavity. In some cases it

is advisable to use a blunt dissector or probe to assist in this procedure. At other times it may be necessary to dilate the orifice, or even to incise it to facilitate its removal. Where the incision is made care should be taken not to penetrate the peritoneal cavity. When the orifice is fairly large, and the stone entirely extravesical, forceps may be introduced through the orifice to grapple and remove the calculus or crush it if too large to be extracted. Occasionally it may be possible to introduce the finger into an adjacent larger diverticulum, and, by pressure upon the smaller diverticulum containing the stone, to force it up to the surface where

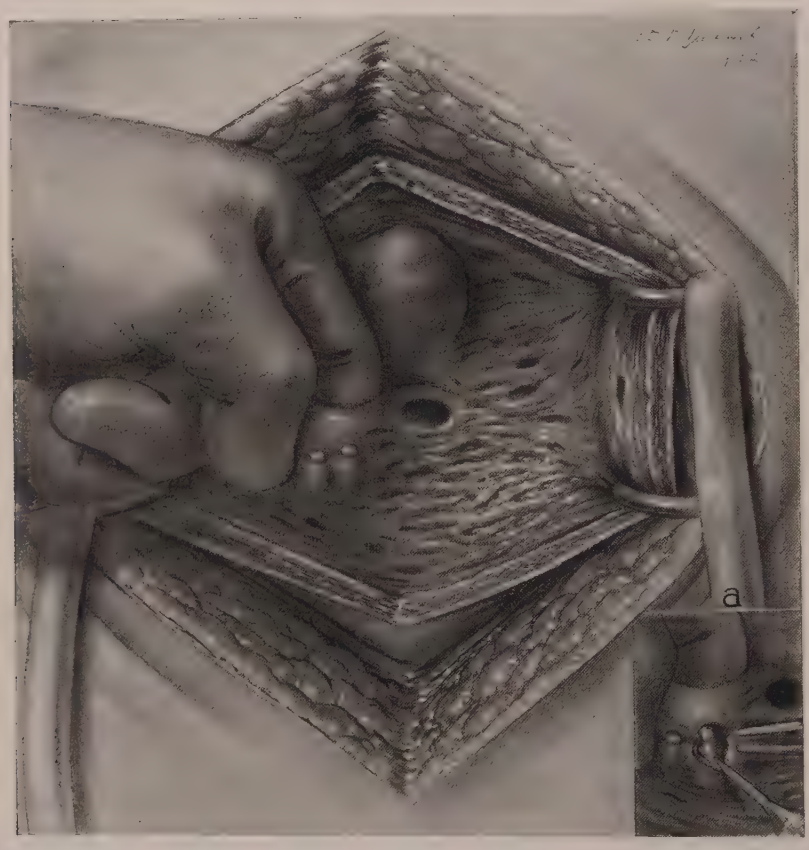


Fig. 719.—Stones removed from larger diverticula, finger introduced, small calculi forced up by finger, bladder wall incised (*a*) to allow removal of small encysted (hour-glass) calculi. Prostatectomy subsequently suprapubically. B. U. I. 10,714.

it may be grappled and removed, either with or without incision of the bladder wall, as shown in Fig. 719.

Multiple diverticula with calculi are not infrequent, and may entail extremely difficult operations for their removal. Great patience and care are requisite in removing every calculus that has been shown upon the *x*-ray plate. After this it is necessary to undertake measures to cure the diverticula, as described elsewhere, so as to prevent recurrence of the calculi.

Calculi encysted and incarcerated within the lumen of the ureter may often require suprapubic operation. They may be entirely covered with mucous membrane and appear as smooth intravesical tumors. Simple incision through the

ureteral wall will allow of their extraction. In some cases it may be necessary to carry this incision upward into the vesical wall. In other cases excision of the balloon-shaped sac which encircles the calculus may be desirable (see Chapter XV).

Vesical calculi which project into the prostatic urethra or prostatic calculi which project into the bladder may be very difficult to remove suprapubically. Not infrequently they present a markedly constricted neck which is encircled by the vesical sphincter. In such cases dilation of the vesical neck should be attempted before deciding on incision to remove the calculus. After having removed all calculi from the bladder or extravesical cavities, etc., thorough lavage should be carried out everywhere to be sure that no sand or fragments remain behind.

The operation of suprapubic lithotomy also varies according to the size of the calculus. Huge specimens have been removed at this clinic, and much larger ones reported in the literature. One of the most interesting is that reported by Randall[1] in the Journal of Urology. In this case the stone measured 48 cm. in circumference and weighed 64 ounces, or 4 pounds. It was removed without injury to the peritoneum or important structures, but unfortunately the patient died. In this article Dr. Randall described other remarkable calculi, none of which, however, was as large as the one reported by him.

PERINEAL LITHOTOMY

Perineal lithotomy was in great vogue in the early days of surgery, but is now almost never practised. In the older methods the incision was either median or lateral and generally divided the triangular ligament, external sphincter, prostate, and internal sphincter. Through this long destructive incision the stone was grasped and extracted with forceps. In the early days of surgery, before the dawn of anesthesia, this operation was done by professional stone-cutters with marvelous dexterity and speed. We regret that we have not space to go into the fascinating literature of these early lithotomists, whose patients included the crowned heads of Europe. The percentage of cures obtained by this operation was remarkably high, and before the days of antiseptic surgery the mortality was much lower than by the suprapubic route. Allen Smith, of Baltimore, even reported 50 consecutive cases without a death, which is almost a record today. The low mortality was almost certainly due to the dependent drainage of urine and infection. The fact that many of these operations were followed by incontinence of urine led to the abandonment of this procedure, so that now perineal attack upon bladder stones is reserved for calculi projecting into the prostatic urethra, or of the bladder associated with prostatic hypertrophy. After perineal prostatectomy, the stone is simply withdrawn by forceps through the prostatectomy wound. Comparative statistics of the mortality in cases of prostatic hypertrophy associated with stone in the bladder show that where the calculus is removed after the enucleation of the prostate by perineal prostatectomy, the mortality is less than half of that in which it is removed suprapubically in conjunction with suprapubic prostatectomy.

DIVERTICULECTOMY

This term is applied to operations for the removal of vesical diverticulum. As pointed out elsewhere, diverticula of the bladder are almost always associated with some form of obstruction. Those which are congenital are probably due to pre-

[1] Journal of Urology, 1921, v, 119–125.

natal obstruction in the prostate or urethra. Those which come on later in life are due to strictures, bars, or prostatic hypertrophy. The points of predilection are external to the ureteral orifice on each side of the bladder and at the vertex of the bladder. As pointed out by English, this is due to the fact that the muscular wall of the bladder is weakened by the insertion of the ureters and the urachus, and that these diverticula are simply herniations from intravesical pressure at these points of vesical defect. Diverticula, however, are often multiple and may occur in any part of the bladder, and vary from the tiny cellule to the huge extravesical pouch which may contain several liters.

The *operative indications* depend entirely on the conditions present, and vary according to the obstruction present and the size and location of the diverticulum. In many cases the diverticulum gives no symptoms which can be differentiated from that of prostatic hypertrophy, and prostatectomy is followed by a gradual diminution, of even a complete disappearance of the diverticula. Where they are large and especially if their walls are adherent to deep pelvic structures, they persist and may give sufficient trouble to require operative intervention. This is especially true if calculi form within them.

The history of operation for the cure of vesical diverticula is of comparatively recent date. The operations may be divided into the extravesical and the intravesical excisions.

Extravesical Excision.—The first case was that of Czerny, who in 1896 removed a large diverticulum extravesically through a transverse suprapubic incision. During this operation the peritoneum and the vas deferens were injured and the ureter, which opened into the diverticulum, was divided and subsequently transplanted into another portion of the bladder. The wound suppurated profusely, the sutures broke down, and a ureteral abdominal fistula resulted. Four months later nephrectomy was necessary.

In 1902 Riedel also removed a diverticulum extravesically through a transverse suprapubic wound. The patient died of collapse.

In 1904 Pagenstecher reported a case in which he removed a large diverticulum through a sacral operation in which the sacrum was resected and the rectum pushed to one side. The ureter was divided and transplanted. The final result was a urinary fistula in the sacral region, and great pain in the region of the kidney. The fourth case was that of von Eiselsberg, who removed a small diverticulum from the vertex of the bladder extravesically. We operated upon the fifth case in January, 1904, removing a large diverticulum through a median suprapubic incision extravesically, and a small diverticulum intravesically. A plastic procedure to preserve the mucous membrane around the ureteral orifice and avoid transplantation was devised and carried out (Fig. 733), and the patient was cured without renal disturbance. This was the first case in which a large diverticulum had been removed through the median suprapubic incision, the first in which a diverticulum had been removed intravesically and the first in which the ureter opening into the diverticulum had been restored by a plastic operation to its normal position in the bladder. Division and transplantation of the ureter were thus avoided.

Suprapubic Extravesical Excision of Diverticulum Without Opening Bladder.—The first case in which this was carried out was one of ours. On February 22, 1904 we removed a very large diverticulum by the following technic: After making a free median line suprapubic incision and pushing back the peritoneum

from the anterior surface of the bladder, the diverticulum was at once brought into view. A metallic catheter, which had been previously introduced, was then passed into the diverticulum, the wall of which was so thin that the catheter could easily be seen through it. Examination then showed that the diverticulum was spread out over the anterior half of the bladder, and extended back around the right side toward the rectum, and upward beneath the peritoneum, being laterally in contact with the pelvic wall and posteriorly with the sacrum. There were no dense adhesions, however, and as soon as the neck had been cut away from the bladder, the sac was drawn out of its bed with ease, and with practically no hemorrhage. It measured about 12 cm. in diameter and probably held 500 c.c. of urine. The closure of the vesical diverticular orifice was effected with a purse-string suture of catgut, placed extravesically so as to invert the edges of the orifice. The bladder was not opened, and no injury was done the peritoneum. The recti muscles were then brought together with interrupted sutures of catgut, and the skin closed with a subcuticular silver suture, leaving a small drain in the lower angle of the wound. The convalescence was uneventful, and there was never any leakage through the suprapubic wound, which healed rapidly.

Since then numerous reports of removal of diverticula by extravesical dissection have been presented. The most important are those of Lerche,[1] who in 1912 described an extravesical extraperitoneal excision of a diverticulum which he had distended by means of a rubber bag introduced on the tip of a ureteral catheter, and of Lower,[2] who reported in 1914 3 cases in which he had packed the diverticula with gauze through a suprapubic incision into the bladder and had then excised them extravesically. In one of these cases the ureter was divided and transplanted.

Intravesical Excision of Diverticula.—The following case, which, as we have mentioned as the first of its kind, was operated on by us in 1904.[3]

B. U. I. 521. The patient, a man of thirty years, had two diverticula, as shown in the accompanying drawing (Fig. 720). As seen here there was a very large diverticulum on the right side

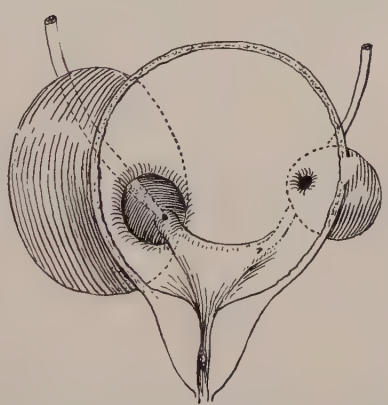


Fig. 720.—Man, aged thirty, with median prostatic bar, residual urine, 330 c.c. Two diverticula, one large, was removed extravesically, the ureteral orfice being preserved and sutured into bladder wound, one small diverticulum which was removed extravesically. B. U. I. 521.

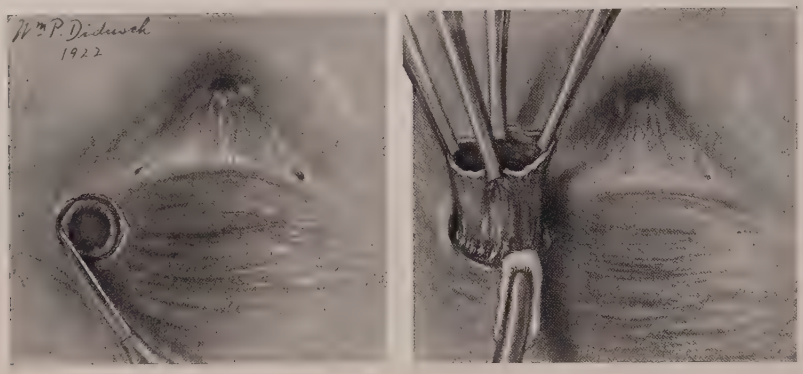
in the wall of which lay the orifice of the ureter and a small diverticulum on the left side external to the ureter. The small diverticulum was removed intravesically as follows:

[1] Annals of Surgery, 1912, lv, 285–304 (Lit.).

[2] Journal of the American Medical Association, 1914, lxiii, 2015–2020.

[3] Young: Johns Hopkins Hospital Reports, 1906, xiii, 402–446.

The prostatic tractor was introduced through the orifice, opened out, and traction made, thus drawing up the diverticulum with the vesical wall which covered it. A circular incision was then made through the mucosa at the vesicodiverticular juncture, and by blunt dissection with the handle of a scalpel, the sac was gradually freed from its investments. The tractor was then removed, clamps applied (Fig. 721), and the sac drawn out (much like the pile-bearing area in Whitehead's operation), and finally enucleated intact. The cavity left was surrounded by a



A B

Fig. 721.—Operation February 10, 1904. Young's intravesical diverticulectomy: A, Circumcision of diverticular orifice. B, Sac freed by blunt dissection as it is pulled out. B. U. I. 521.

thick fibrous wall, which it was thought best to drain extravesically, so that the opening of the bladder could be closed by an intravesically placed purse-string catgut suture. The patient made an excellent recovery.

Since 1904 we have removed all diverticula intravesically. In some of these cases the procedure was that above described, the diverticulum being drawn into the bladder after a circular incision around its orifice, the procedure being somewhat similar to that of a Whitehead operation for hemorrhoids. In some of the cases a great deal of the wall of the diverticulum was removed intact. In other cases the outer portion of the sac was very adherent and a satisfactory line of cleavage within was sought for and the enucleation carried out. Sometimes a fairly thick fibrous sac was thus removed. In other cases little more than mucous membrane came away.

Recently Geraghty[1] has reported similar cases in which he found that removal of the mucous membrane alone was sufficient for cure in difficult cases, the primary incision being at the diverticular orifice, as above described, the mucous membrane being dissected free from the sac and gradually drawn into the vesical cavity.

In 1909 a case of diverticulum containing a large carcinoma which was removed intravesically was reported by us.[2]

Everting Sac into Bladder by Suction.—The next step in the history of the operative attack upon diverticula was that of *intravesical eversion of the sac.* In the first case, this was done by means of suction. The operation was briefly described as follows:

B. U. I. 591, W. B. E., aged forty-seven. The patient had had previous prostatic hypertrophy and perineal prostatectomy. The obstruction was relieved, but the patient suffered from cystitis, frequent urination, and residual urine. Examination showed, on the left lateral wall,

[1] Southern Medical Journal, 1922, xv, 54–57.

[2] Young: Transactions American Association Genito-Urinary Surgeons, 1909, iv, 121–125.

the orifices of four small cellules and, on the right lateral wall, several cellules. Two or 3 cm. external and posterior to the right ureteral orifice a fairly large diverticulum was visible. The prostatic orifice showed a rounded lobule anteriorly. The residual urine was 240 c.c. and the bladder capacity 500 c.c. At operation, April 13, 1914, it occurred to us to use suction through a glass tube to draw the diverticulum within the bladder (and turn it inside out), and this was accordingly carried out with really spectacular results. A large glass tube was introduced, and very shortly after suction was applied the pale mucous membrane of the diverticulum was seen mounting within the tube. This continued until it had been drawn fully $1\frac{1}{2}$ inch within the tube, which was then drawn out slowly. When the end of the tube appeared in the bladder the mucous membrane was quickly caught with forceps, the diverticulum delivered into the bladder, circumcised at its neck, enucleated and removed. The opening was closed without entering the peritoneal cavity. The suprapubic wound was drained and the patient made an excellent recovery and had a splendid ultimate result.

Cases operated upon by this method were collected and reported in 1918.[1] In this report 7 cases are enumerated, in each of which from one to six diverticula

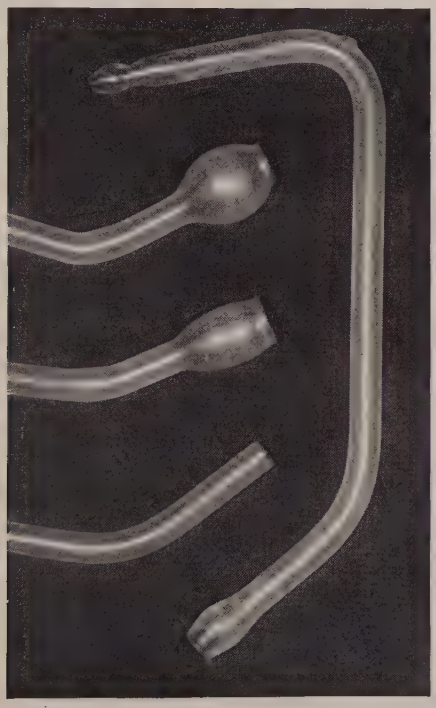


Fig. 722.—Glass tube to be used with vacuum pump or powerful piston syringe to draw diverticula within bladder. Various types for different orifices. Straight tubes, without bulbous enlargements, do perfectly well.

were removed intravesically by enucleation of the sac. In all of these cases the suction method had been successful in drawing the diverticulum more or less completely into the bladder. In some instances only the tip of the diverticulum presented and forceps were then used to draw the mucous membrane into the bladder. In many cases, however, only a portion of the sac could be everted into the bladder, and the circular incision and removal by blunt dissection according to the Whitehead procedure, which we employed in 1904, was utilized. In some cases forceps alone were used to draw the sac into the bladder.

[1] Young: Surgery, Gynecology, and Obstetrics, 1918, xxvi, 125–132.

Young's Operation of Intravesical Diverticulectomy.—As indicated in the preceding remarks on the history of diverticular surgery, the operative procedure which is required to remove a diverticulum varies according to the position of the diverticulum, its size, and its relation to the ureter. Almost all diverticula can be removed intravesically, a procedure, in our opinion, much to be preferred to the extravesical dissecting method. If the diverticulum can be drawn into the bladder and everted, the operation is greatly facilitated. The method which we employ for this is as follows:

Glass tubes of varying size, as shown in Fig. 722, are prepared. As seen here, they are provided with an aperture near the outer end which can be closed with the

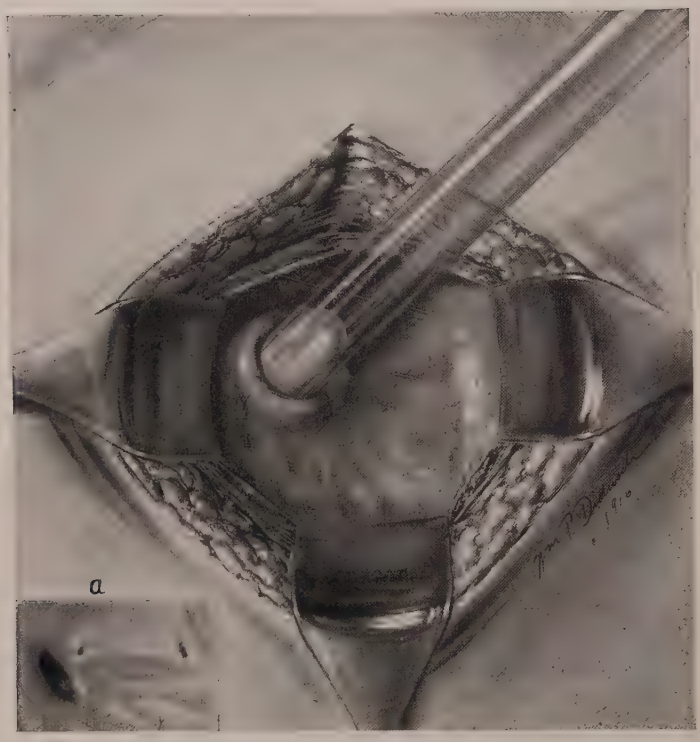


FIG. 723.—Young's intravesical diverticulectomy. The mucosa of the diverticulum may be seen being drawn up into the glass suction-tube. Insert *a* shows diverticular orifice before insertion of tube. In this drawing, as in the following seven, the symphysis pubis is shown uppermost. B. U. I. 5481.

thumb when suction is applied. The bladder is first opened widely through a suprapubic extraperitoneal incision, the patient being in a marked Trendelenburg position, and the bladder held open laterally by a self-retaining retractor. A gauze pad, to which a string is attached, is usually rolled up and placed beneath the posterior retractor, as previously described under suprapubic cystotomy. Diverticula, which have been previously detected by cystoscopy or cystograms, are then sought for and located. In many cases the orifices are so small that they are only found by probing. When located it may be well to insert ligatures in the orifices so that they may subsequently be found with ease. In attacking a diverticulum, if the orifice is small, it may be dilated with forceps or glove stretcher so as to admit the largest possible glass suction-tube. The pump should be started beforehand and the bottle

reduced to a considerable negative pressure ("vacuum"). A glass tube of appropriate size is selected and introduced into the diverticulum until it strikes bottom. It is then connected up with the heavy rubber tube which leads to the vacuum bottle. The thumb is placed across the orifice, the clamp removed from the rubber tube, and suction upon the diverticulum begun. After a lapse of a short period, sufficient for the mucous membrane to be caught up into the lumen of the glass tube, it is slowly withdrawn for a short distance while suction continues and the pump runs on. The tube is then withdrawn a few millimeters more (in large diverticula perhaps a centimeter or two), and after a time the wall of the diverticulum will be seen traveling upward in the interior of the glass tube (Fig. 723). This should be allowed to continue as long as possible, the tube being slowly

FIG. 724.—Intravesical diverticulectomy, eversion of diverticulum by suction, toothed clamp in position to grasp sac drawn into bladder. B. U. I. 5481.

withdrawn, bringing with it the diverticular wall within its lumen. In the absence of a sufficiently powerful suction apparatus, a large syringe may be entirely satisfactory in everting the diverticulum with a glass tube as above described. In some cases in which the diverticulum is intraperitoneal or where the adhesions are slight, the diverticulum may be turned inside out, within the bladder, by this suction method alone. In many cases, however, this is not possible, and it is then necessary to grasp the partly everted diverticulum with strong toothed forceps beneath the end of the glass tube (Fig. 724).

In many cases this procedure has to be carried out very quickly to prevent the escape of the diverticular wall back into the diverticular orifice. When the diverticulum has been completely everted, as shown in Fig. 725, and where the ureter

is in no way associated with it, as shown in previous examination or by inspection of the everted diverticulum, a circular incision is made around the diverticulum through the mucosa and submucosa. By blunt dissection the mucous membrane, submucosa, and a layer of the fibrous wall of the sac (if possible) are separated from the deep portions of the sac, as shown in Fig. 726. Proceeding thus, the entire sac is gradually freed by blunt dissection, vessels which are encountered being clamped and ligated. Great care is taken not to make the dissection too deep or to enter

FIG. 725.—Intravesical diverticulectomy. The intravesical delivery of the diverticulum has been completed by the use of clamps, making traction at various points around the circumference. Insert *a* shows circular incision around neck of diverticulum and beginning elevation of the mucosa. B. U. I. 5481.

the peritoneum which is often found with contained intestines within the everted diverticular sac. This is then pushed back through the orifice in the bladder wall and an investigation of the extravesical cavity made with the finger to determine whether the peritoneum has been opened. Before closing the hole in the bladder wall the question of drainage must be considered. Some authors simply insert a drainage-tube through the orifice, which is tightened around it by catgut sutures. We prefer an extravesical drainage which is obtained as follows: The lateral wall of the bladder is freed from adhesions and, with a markedly curved

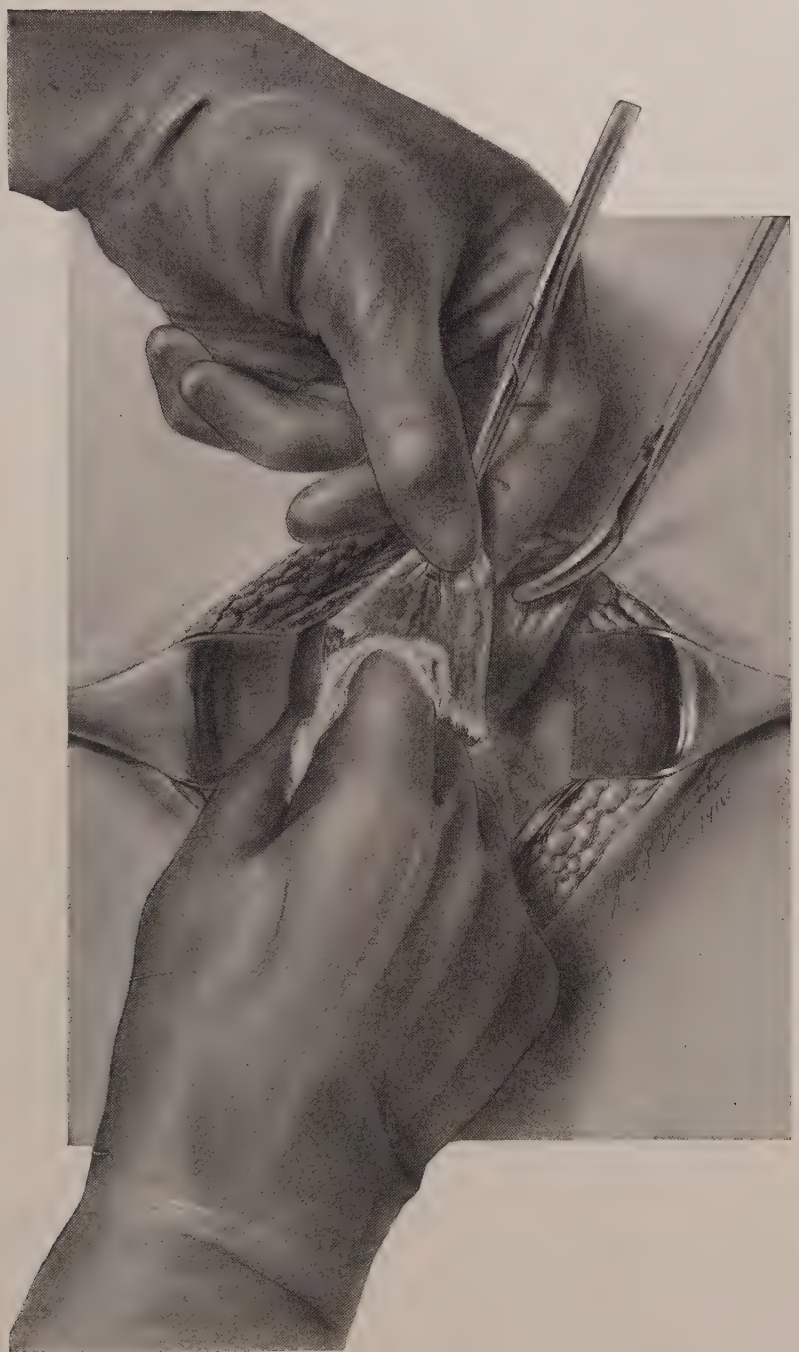


FIG. 726.—Intravesical diverticulectomy. A circular incision has been made through the mucosa at the neck of the diverticulum, the mucosa elevated at one point, and blunt dissection begun, peeling out the lining membrane of diverticulum. B. U. I. 5481.

clamp in the diverticular cavity, a communication is effected between this and the lateral extravesical space. A small rubber tube or a cigarette drain is then drawn into the diverticular cavity, extravesically, as shown in Figs. 728 and 729, after

which the orifice of the diverticulum is closed with a continuous chromic catgut suture tied intravesically (Fig. 728).

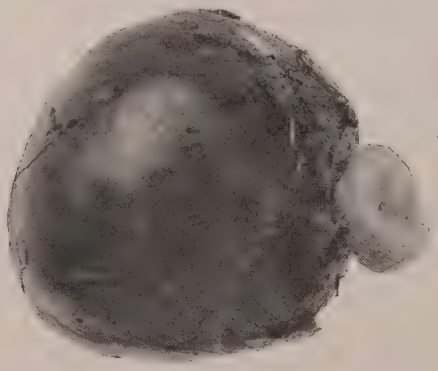


FIG. 727.—Photograph of diverticulum excised intravesically after being drawn into bladder by suction. B. U. I. 5481.

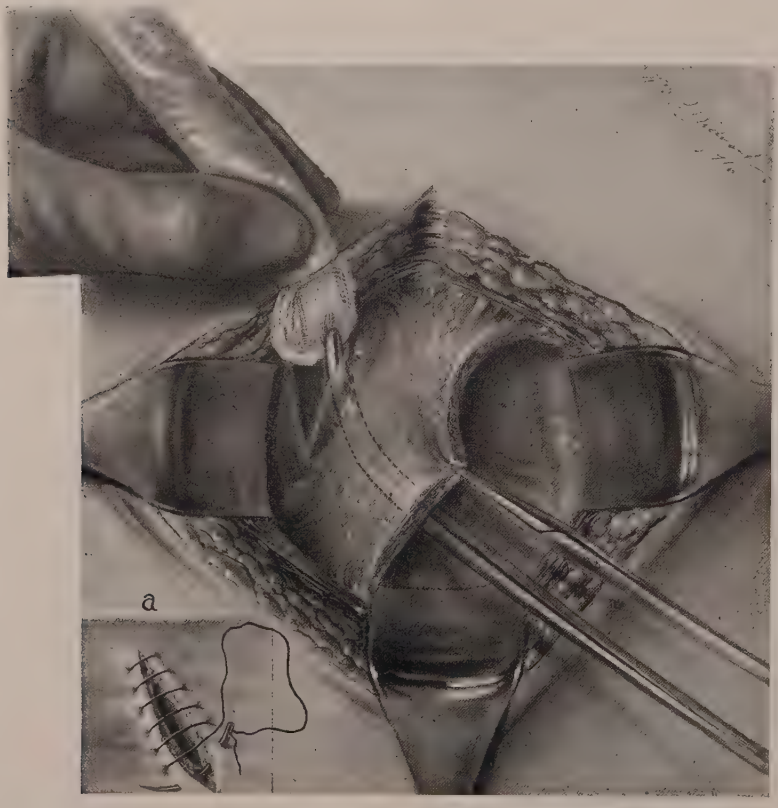


FIG. 728.—Intravesical diverticulectomy. The site of the diverticulum is drained extravesically by means of a cigarette drain carried down lateral to the bladder. Bladder mucosa is then closed with a continuous catgut, as shown in insert *a*. B. U. I. 5481.

Where it is not possible to draw up and evert the mucous membrane by our suction method three variations in technic may be employed: 1. An Allis clamp or curved tooth-forceps (Kocher) may be introduced to catch the mucous membrane of the

diverticulum and draw it through the orifice into the bladder, where, with additional clamps, one may succeed in everting the diverticulum (Fig. 731).

2. *Extravesical pressure* may be employed after freeing the extravesical space down to the diverticulum, to push the mucous membrane of the diverticulum into the bladder by means of the index-finger introduced extravesically (Fig. 730). Where the diverticulum projects within the peritoneal cavity this may sometimes be accomplished through the peritoneum, but without opening the peritoneal cavity. In some cases where the diverticulum is on the high posterior wall it may be desirable even to open the peritoneum and with the finger in the abdominal cavity to push the diverticulum into the bladder or to assist the intravesical enucleation of the diverticulum.

Fig. 729.—Intravesical diverticulectomy. The extravesical cigarette drain leading to extravesical cavity from which diverticulum was removed is shown. Bladder is being closed. B. U. I. 5481.

3. The *diverticulum may be enucleated without eversion* as done in our first case in 1904 (Fig. 721). An incision is made around the diverticular orifice through the submucosa, the mucous membrane being caught up with forceps and gradually drawn into the bladder as the sac is freed by blunt dissection. By insertion of the finger into the diverticulum, as is done in the Whitehead hemorrhoid operation to facilitate blunt dissection, we may proceed to draw out the sac, and remove it in entirety. With one index-finger in the diverticulum the other index-finger may be used, outside of the sac, to enucleate the diverticulum. This "two index-finger method" we have found very effective in deep adherent retrotrigonal diverticula.

The amount of diverticular wall removed varies with the case. In some of our cases dissections have shown fibrous and muscle tissue beneath the submucosa of the excised sac. In other cases a thin layer of fibrous tissue lies beneath the mucous membrane and in other cases only the mucous membrane has been removed, but this is entirely sufficient if carried out completely. When the orifice of the diverticulum is small, one or more incisions radiating from the opening through the muscular wall of the constricting vesical ring may be of great help in

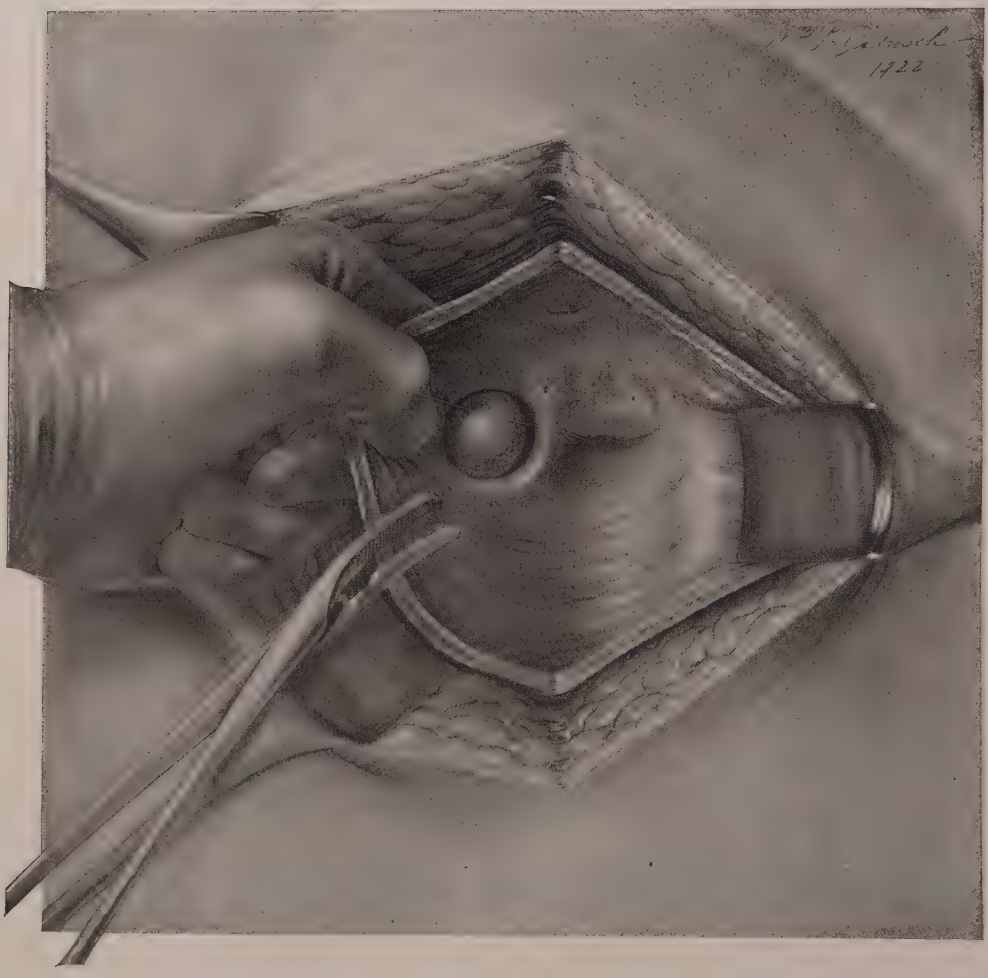


Fig. 730.—Intravesical diverticulectomy, variation of technic, finger in left lateral perivesical space pressing diverticulum into bladder; clamp ready to catch mucosa of diverticulum. B. U. I. 10,125.

removing the sac. This is particularly true where the diverticulum is very large (Fig. 731).

As pointed out in the chapter on encysted calculi, one may use the finger in an adjacent diverticulum to bring to the surface or invaginate the diverticulum under attack. The same procedure may also be used through the cavity left by the excision of one diverticulum.

Résumé: By one or more of the methods above described (eversion with suction, clamps, or extravesical pressure with the finger, circular incision and gradual

removal by the Whitehead method) diverticula, large or small, can, we believe, be invariably removed intravesically. Our intravesical diverticulectomy is simpler, safer, less bloody, and much to be preferred to the extravesical operation of Czerny.

When the ureter opens within the diverticulum a special technic has to be employed. Before operation it is wise to determine with the cystoscope exactly where the orifice of the ureter lies within the diverticulum. It might be well to carry out preliminary ureteral catheterization, but we have never done this. At

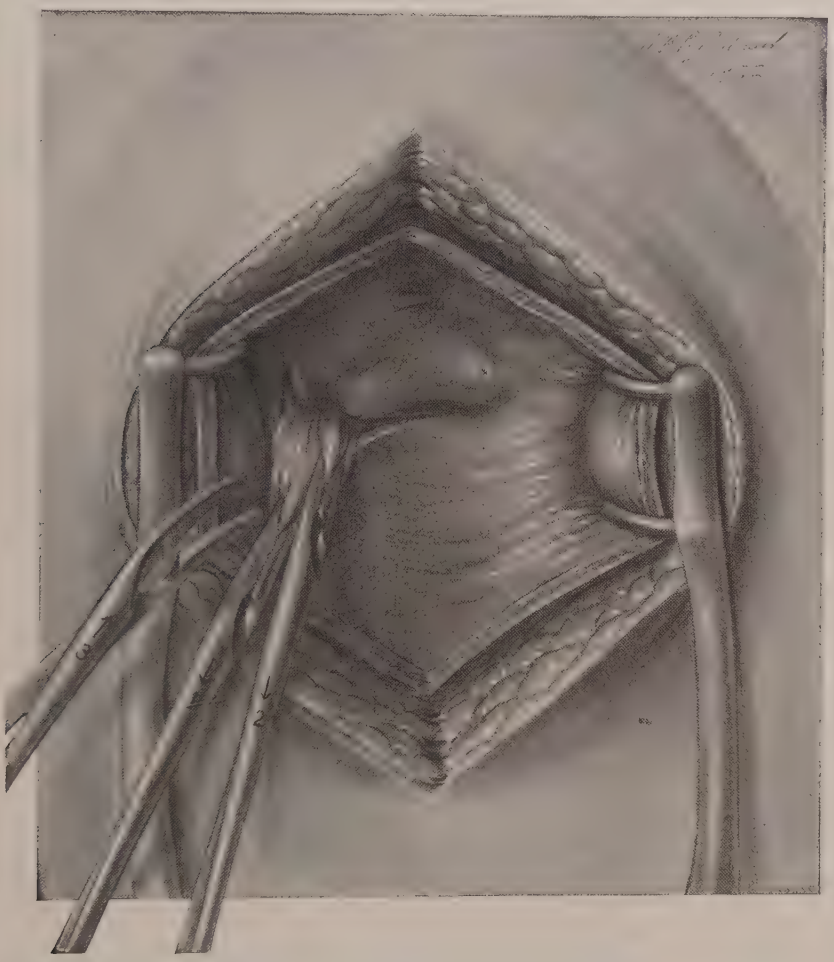


FIG. 731.—Intravesical diverticulectomy. The orifice has been enlarged by incisions through mucosa and muscle. The diverticular sac is being drawn into the bladder. B. U. I. 10,125.

operation attempt may be made, before attacking the diverticulum, to locate the orifice of the ureter, but we have generally found it impossible to find it through the diverticular orifice. When the diverticulum has been everted completely, one can usually find the orifice of the ureter on the surface of the everted sac. Sometimes, however, it may be obscured in the folds of mucous membrane. In such cases the operator must be careful to make the incision along the diverticular neck at a point quite distant from the supposed location of the ureter, and to proceed carefully with the dissection. As the sac is freed and the deep contents pushed back

FIG. 732.—The left ureteral orifice lay within the diverticulum. After invagination of the diverticulum a horseshoe incision was made around the sac so as to preserve the interureteral ridge. The lining membrane (mucosa and submucosa) is being peeled up, and the underlying tissues (including ureter) pushed back. Ureter was palpable and indistinctly visible, although it was not dissected free. *U*, Ureter. B. U. I. 5682.

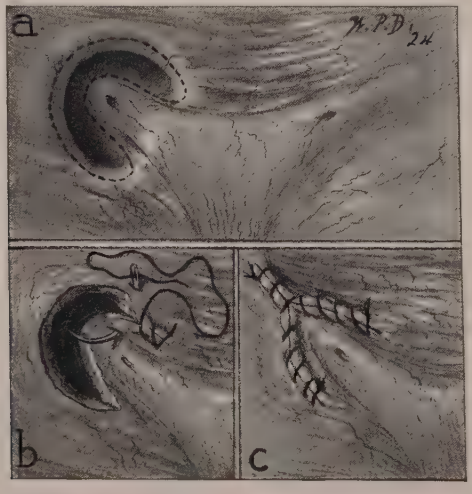


FIG. 733.—*a*, Large diverticulum with ureteral orifice within it, dotted line showing line of incision to preserve ureter. *b*, Condition after excision of diverticulum, ureter drawn into bladder, closure begun. *c*, Closure in form of Y, ureter replaced in bladder. Bottini operation subsequently to remove persistent obstruction. B. U. I. 521.

toward the peritoneal cavity, one can usually see the ureter thus exposed, as it joins the sac from behind, as shown in Fig. 732. Having thus located the ureter and its orifice externally, a flap of mucous membrane and submucosa is formed by means of knife and scissors so as to include the ureteral orifice. When the closure of the opening is made with catgut, care is taken to see that the ureteral orifice is well back within the bladder. Often this will require a Y-shaped form of closure, as shown in Fig. 733, *c*, but in some cases it is well retained by the simple linear sutures (Fig. 733, *b*). In none of our cases has it been necessary to divide the ureter and transplant it into the bladder. Study of the literature shows that when ureteral transplantation was done, it was frequently followed by pyonephrosis, requiring nephrectomy. Transplantation of the ureter should undoubtedly be avoided, if possible, and the technic above described is entirely satisfactory whether the diverticulum be removed intravesically or extravesically. The final closure of the bladder with extravesical drainage is shown in Fig. 729.

It is scarcely necessary to say that the obstructive lesion should always be attacked by prostatectomy, punch, or other suitable procedure. In some cases this will already have been done, in others it may be necessary to defer it for a time, but it should never be neglected.

The following illustrative cases may be cited:

Large diverticulum of bladder everted by suction. Intravesical diverticulectomy; punch operation for prostatic obstruction.

B. U. I. 11,752, aged sixty-five years, admitted September 22, 1923. Complaint: Difficulty of urination. Gonorrhea at the age of twenty-eight, followed by stricture. Treated by internal urethrotomy and sounds in 1894. Ten years ago urination again became difficult; sounds were passed to relieve condition. Has also been treated by massage of the prostate and irrigations of bladder. During past year urination has again become difficult to start, with stoppage two or three times during urination, burning in urethra and offensive urine. No history of chills or fever. No hematuria. No complete retention of urine. At present voids urine four or five times during the day. Does not have to get up at night.

Examination.—Patient strong and apparently healthy. Urine cloudy with pus and bacteria. Prostate not enlarged, slightly irregular, slightly indurated and adherent. Seminal vesicles negative. Cystoscope passes easily. No stricture. Residual urine, 290 c.c. Bladder capacity, 375 c.c. Tonicity good. Prostatic margin normal in appearance, no definite median bar seen. All of trigone visible and normal. Bladder not trabeculated. Orifice of large diverticulum on posterior wall. One small cellule but no other diverticula seen. With finger in rectum and cystoscope in urethra, trigone thickened and median portion of prostate thicker and harder than normal, forming a definite ring around shaft of instrument.

Remark.—This case is remarkable in that rectal and cystoscopic examination show no evidence of prostatic enlargement or obstruction, but examination with finger in rectum and cystoscope in urethra shows a definite hard collar, probably explaining the large residual urine and the diverticulum.

September 28, 1923: Operation, Young; gas, oxygen, and ether. Suprapubic cystotomy; excision of large vesical diverticulum; punch operation. Bladder opened suprapubically. Diverticular orifice found 2½ cm. behind trigone. The vesical orifice was tight and on attempt to insert the finger into the prostatic urethra a fibrous ring was evident. No enlargement, lobes palpable, orifice difficult to dilate. The diverticular orifice was dilated and a large curved glass tube, prepared for suction, inserted for a distance of 5 cm. Closing the opening in the tube with a finger, suction was induced and, after a time, gentle traction made. The mucous membrane of the diverticulum soon appeared, traveling outward in the glass tube, which was then drawn out slowly until the sac could be grasped with forceps. It was necessary to divide the diverticular orifice by an incision downward toward the trigone in order to evert the sac completely. A circular incision was made around the neck of the sac and the mucosa and submucosa stripped off, thus removing the sac entirely. Peritoneum not injured. A large cavity remained behind the

bladder and this was drained by an extravesical rubber tube. Diverticular orifice closed with continuous, plain, heavy, catgut suture.

A punch operation was then done. The first cut was made posteriorly and a large block of fibrous tissue removed. Two lateral cuts were then made, removing smaller pieces of tissue similar in character. The prostatic orifice was found to be widely dilated; no enlarged lateral lobes present. Hemorrhage slight and ceased after urethra was packed with gauze, which was brought out through the suprapubic wound. Bladder drained with a large mushroom catheter and partially closed with continuous chromicized catgut suture. Skin, fascia, and recti muscles approximated with silver sutures. Skin closed with metal clips.

Pathologic Report.—Specimen consists of a pear-shaped diverticulum which has been removed intact. It measures 8 x 5.5 x 4.5 cm. Microscopic examination shows normal mucous membrane with a small amount of smooth muscle beneath it. The section of the prostate removed by the punch shows slight glandular hypertrophy with round-cell infiltration beneath the mucous membrane.

November 19, 1923: The convalescence has been uneventful except that the suprapubic fistula has been slow in healing. The fistula is now closed and patient is voiding normally four times a day and once at night without pain and with excellent control.

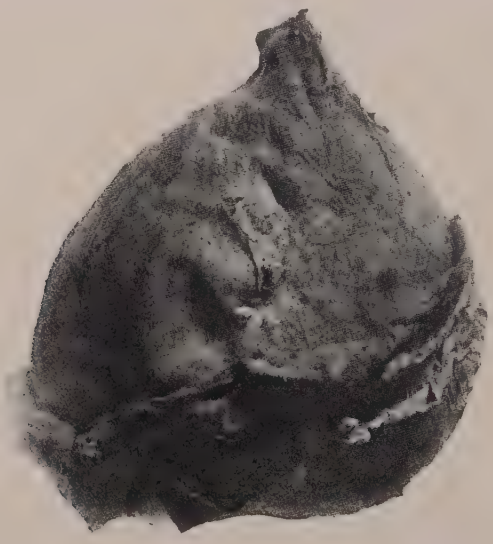


FIG. 734.—Diverticulum of right anterolateral wall of bladder, excised extravesically without opening bladder. B. U. I. 558.

Very large diverticulum removed extravesically; bladder not opened.

B. U. I. 558, man aged sixty-three years, admitted February 22, 1904. About two years ago patient began to have increased frequency and difficulty of urination. During the past year, although nocturnal frequency has not increased and he voids only twice during the night, he has had much more trouble in the day time. At times he voids three or four times an hour. These attacks of great frequency are associated with a feeling of pressure and desire to urinate, which persists after voiding. If patient is exposed to cold he urinates very frequently, only a few drops at a time, but when he gets warmed up thoroughly voids at considerable intervals. Has never had complete retention of urine, nor used a catheter, nor had any severe pain.

Examination showed moderate enlargement of the prostate. Cystoscopy: 1200 c.c. residual urine, moderate hypertrophy of both lateral and median lobes, moderate trabeculation; no cystitis. In the right anterolateral wall of the bladder there is seen the orifice of a diverticulum apparently about 1 cm. in diameter. Cystoscope easily introduced through this opening into a very large extravesical cavity, the walls of which are smooth.

February 23, 1904: Operation, Young; ether. Suprapubic extravesical removal of large diverticulum; perineal prostatectomy. Median abdominal incision; exposure of anterior surface of bladder by pushing peritoneum backward; disclosure of large thin walled diverticulum

which covered the right half of the bladder and extended posteriorly into the pelvis. The diverticulum connected with the bladder by a narrow neck located 2 cm. from the median line anteriorly and 4 cm. above the prostatic orifice. The diverticular wall was so thin that a silver catheter, which had been introduced into the bladder and passed through the diverticular orifice, could be seen shining through. By blunt dissection this sac was easily separated from the bladder. A clamp was placed across the neck which was then divided next to the bladder. By blunt dissection the diverticular sac was then freed from the lateral wall of the pelvis and the peritoneum and removed intact (Fig. 734). A finger was then inserted with difficulty through the diverticular orifice into the bladder and examination showed a small hypertrophied collar around the prostatic orifice. The diverticular opening was then closed by a purse-string suture, which inverted the edges of the mucous membrane. Recti muscles approximated by silver wire. A small suprapubic drain inserted. Perineal prostatectomy. With patient in perineal position our typical operation for prostatectomy was carried out. The lateral lobes measured 3 x 4 x 5 cm. each and the median lobe about 3 cm. in diameter. Drainage of bladder through membranous urethrotomy, lateral cavities packed with iodoform gauze. Skin wound partially closed.

Convalescence.—There was never any leakage of urine through the suprapubic wound. During the second week the patient was voiding naturally through the urethra.

October 15, 1906. (Report by physician.) The operative result has been excellent. Urine has been voided freely at intervals of two or three hours. For two weeks suffered considerably with his heart, and he died today. No autopsy.

Vesical Diverticulum.—Intravesical removal; no drainage supplied for diverticular cavity. Perineal prostatectomy. Retrovesical extravasation requiring incision in left side. Final cure. A case exemplifying development of prostatic hypertrophy in anterior commissure not removed by operation. Suprapubic prostatectomy subsequently.

B. U. I. 1261, age fifty-three years, admitted April 10, 1906 with frequency and dysuria. Micturition now six times during the day, but not at all at night. On rectal examination the prostate was found only slightly larger than normal. Seminal vesicles negative. Cystoscopy; residual urine 250 c.c. Bladder capacity large. Study of prostatic orifice shows small, round median bar, no enlargement of lateral lobes and shallow sulcus anteriorly. In the left corner of the trigone is a diverticular orifice; the ureteral ridge disappears within this and the ureteral orifice cannot be seen.

May 15, 1906: Operation, Young; ether. Perineal prostatectomy. The lateral lobes of the prostate were only slightly larger than normal and were easily removed each in one piece. Median portion of prostate removed through the left lateral cavity. Examination showed a fibrous ring remaining and a section of the posterior portion was removed with forceps and scissors, leaving a large opening through which the finger was inserted and showed no remaining enlargement of laterals or other portions of the prostate. Perineal drainage; partial closure of skin.

Convalescence excellent, no complications. Perineal fistula closed in twelve days. Patient left hospital in third week in excellent condition.

June 24, 1907: Patient reports for examination. Feels well. Entirely relieved of dysuria. Is able to retain urine five to six hours. Has no hesitation or difficulty of urination. Coitus normal. Examination of prostate by rectum shows prostate to be smaller than normal. Cystoscopy: No residual urine. Bladder capacity, 500 c.c. Cystoscope shows no enlargement of median portion, but two small, rounded nodules projecting from the upper portion of each lateral lobe and coalescing anteriorly without intervening cleft. Diverticulum still present and contains the left ureter. Urine contains bacilli and a few pus cells.

February 8, 1919: Now thirteen years since operation. Patient returns complaining of frequency of urination and pain. On rectal examination the prostate is not enlarged.

February 11, 1919: On cystoscopy we find 220 c.c. residual urine. Bladder capacity 800 c.c. Cystoscope now shows small, round anterior lobe and two small, rounded lateral lobes. Median portion not enlarged. Diverticulum of left half of bladder containing ureter. A second diverticulum is now visible just back of the larger diverticulum. Cystoscope inserted into the diverticulum shows orifice on the inner lower aspect. Ureter catheter can be passed into it without much difficulty. The urine from the left kidney is cloudy and contains pus cells and a few bacteria. Total phthalein 50 per cent. in two hours.

February 14, 1919: Operation, Young; gas, oxygen, and ether. Suprapubic diverticulectomy. Removal of two diverticula which had been drawn into the bladder by suction. Orifices closed with interrupted sutures of chromicized catgut. The ureter which lay within the

left diverticulum was restored to its normal position. The orifice of the small diverticulum was not closed. No extravesical drainage for diverticular region provided. Suprapubic prostatectomy performed. A small globular lobe about 2 x ½ cm. in size was removed. This lay anterior to the urethra. No other lobes could be found and nothing else was enucleated. A large orifice remained. Partial closure of suprapubic wound with silver wire.

Convalescence was satisfactory until three weeks after operation, when for three days he had nausea, elevation of temperature, leukocytosis 14,000. One month after operation a localized induration and tenderness appeared in the left side of abdomen just above the crest of the ilium. A diagnosis of retroperitoneal abscess was made March 14th. Incision of retroperitoneal abscess through cutaneous incision above crest of ilium. Examination showed that the abscess extended down into the pelvis behind the bladder and evidently originated from the retrovesical wound from which the diverticulum had been removed. It extended up to the region of the kidney, which could be palpated but which was apparently negative. Smears from the pus removed showed cocci and bacilli. The wound healed slowly by granulation. There was never any leakage of urine through the wound and no operation was necessary upon the bladder. The patient was discharged on April 26th in excellent condition. Had no further difficulty but subquently developed bronchiectasis (with a mycotic infection).

Very large diverticulum, contracture of vesical orifice, intravesical diverticulectomy.

B. U. I. 10,892, A. T. K., age forty-eight, admitted October 20, 1922. History of difficulty and frequency of urination for thirteen months. Several months ago urination became very difficult and since then catheter has been used twice daily; the amount of residual urine is about 500 c.c.; patient is able to void small amounts with difficulty. Examination: Patient is in good general condition; prostate slightly broader than normal but not indurated. Cystoscopy: Retention complete; definite enlargement of lateral and median portions of prostate with shallow clefts seen; in region of right ureter an orifice of a large diverticulum seen; with finger in rectum and cystoscope in urethra, suburethral portion of prostate markedly thickened; lateral lobes slightly enlarged. Cystogram shows a large diverticulum on right side of bladder (see Fig. 34). Phthalein test: Appearance time, ten minutes; first hour, 40 per cent.; second hour, 22 per cent.

October 27, 1922: Operation, Young; gas, ether. Suprapubic cystotomy; intravesical enucleation of large diverticulum; extravesical drainage of diverticular space; intravesical closure of diverticular orifice; punch operation, 3 cuts—posterior, right, and left lateral. By suction a small amount of mucous membrane was drawn up and caught with clamps, but it was impossible to deliver entire diverticulum; circular incision around orifice and radial incision through bladder muscle. The diverticulum was very large, and adherent to wall of pelvis, sacrum, and rectum, but was removed completely in one piece. Punch operation: Three cuts completely removed the prostatic obstruction. Pathologic report: Specimen consists of wall of diverticulum 5 cm. in diameter and of varying thickness, between 2 and 10 mm.; microscope showed chronic inflammation, marked fibrosis, no muscle. Convalescence uneventful but slow on account of tardy closure of suprapubic fistula. On discharge, wound was healed; patient voiding naturally without difficulty. Phthalein: Appearance time six minutes; first hour, 60 per cent; second hour, 15 per cent.; general condition excellent.

Very large diverticulum; contracture of vesical orifice; intravesical diverticulectomy; punch operation; cure.

B. U. I. 10,153, F. N. S., age fifty, admitted December 3, 1921. History of difficulty of urination for ten years; never any marked frequency, voids four or five times during day and none at night. Examination: Patient in good general health; prostate normal in size and only slightly enlarged, not indurated; residual urine 800 c.c., bladder capacity 900 c.c. Cystoscope shows an irregular orifice, a definite posterior median bar, anterior margin also slightly rounded, lateral margins negative; with finger in rectum and cystoscope in urethra no enlargement of the prostate made out; median portion normal in thickness; bladder trabeculated; on left lateral wall of bladder 5 cm. from prostate is orifice of a diverticulum into which the cystoscope passes with ease; wall is smooth, diameter about 7 cm., orifice about 2 cm. in diameter and about 5 mm. external to left ureteral orifice. Urine sterile and free from pus. Phthalein: Appearance time ten minutes; 75 per cent. in two hours.

December 9, 1921: Operation, Young; gas, ether. Suprapubic intravesical diverticulectomy; punch operation. The diverticulum was delivered into the bladder with suction and clamps. The sac was very thin and frequent tears were made into it; in one place the peritoneum being very closely attached was torn; the vas deferens was seen attached to the wall of the

diverticulum and carefully avoided. The sac, when removed, was much larger than an orange; the cavity left was drained extravesically with rubber tube and cigarette drain.

Punch operation, five cuts, removing the obstruction completely; orifice of diverticulum closed intravesically with chromicized catgut. Pathologic report: Wall of the diverticulum is approximately 1 mm. in thickness and composed of mucous membrane and fibrous tissue; microscope shows slight infiltration of mucous membrane and submucosa. Specimen from prostate showed chronic inflammation but no enlargement of the glands.

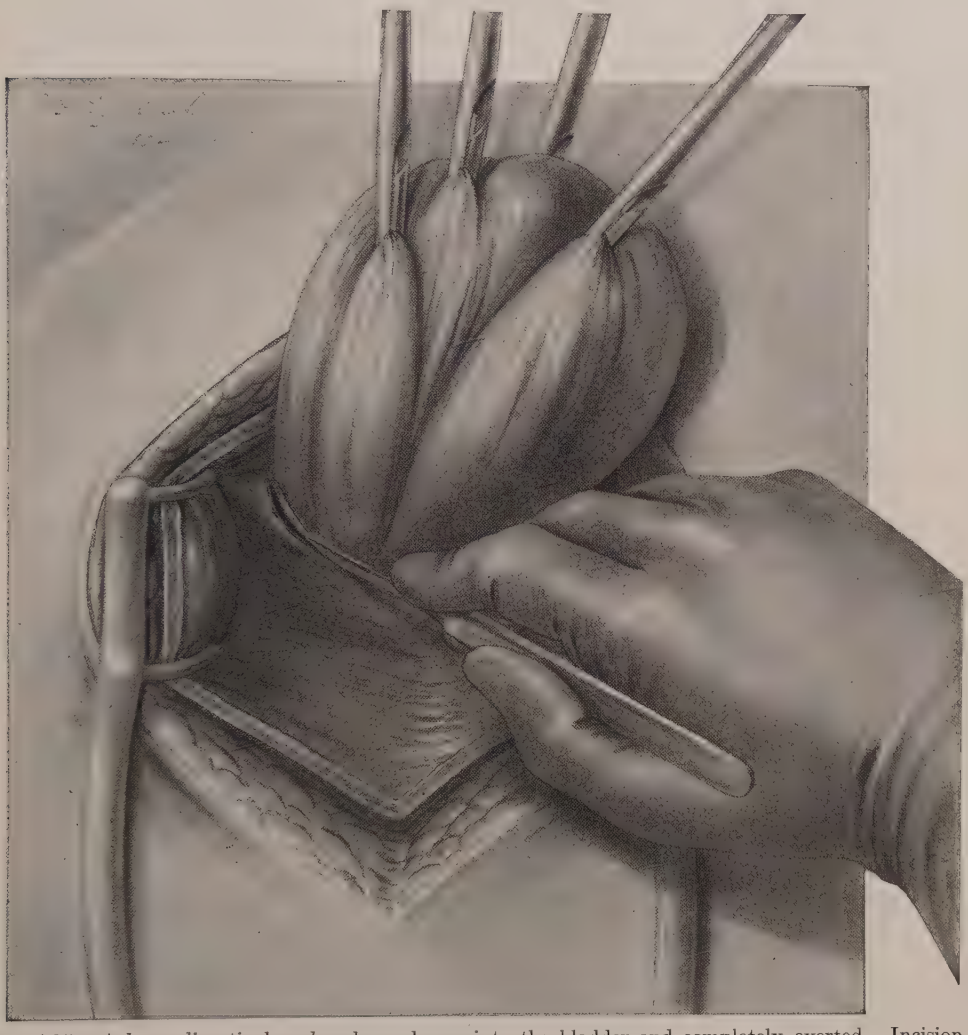


FIG. 735.—A huge diverticulum has been drawn into the bladder and completely everted. Incision around neck begun. B. U. I. 10,125.

Convalescence slow; fistula did not heal until sixty-one days after operation; ultimate result excellent. Report one year later: "Am voiding naturally; stream large; have gained in weight; general health splendid."

Large vesical diverticulum; median prostatic bar; vesical calculus; intravesical diverticulectomy without suction; punch operation.

B. U. I. 9808, J. E. B., age seventy-three, admitted July 5, 1921. Urinary frequency of eight years' duration; has passed gravel for the past two years; catheter life for four years; small amounts voided, but with marked hesitancy, urethral pain, frequency, and dribbling. Examination: Patient emaciated and pale; prostate only slightly broader than normal, smooth, elastic;

residual urine 100 c.c., bladder capacity 200 c.c. Cystoscope shows no clefts, slight rounding of both lateral and posterior margins; trigone partly obscured; external to the right ureter is the orifice of a very large diverticulum; the bladder is only slightly trabeculated, but numerous cellules are present posterior to trigone; urine contains much pus and cocci. Plain *x*-ray shows a stone in the bladder and cystogram shows a large diverticulum on the right side (Fig. 41). Phthalein: Appearance time ten minutes; 55 per cent. for two hours.

Fig. 736.—Intravesical diverticulectomy; separation of sac (mucosa, submucosa, and a portion of fibrous wall) from deeper tissues. B. U. I. 10,125.

July 11, 1921: Operation, Colston; gas, ether. Suprapubic intravesical diverticulectomy; removal of calculus; punch operation, 6 cuts necessary to enlarge the orifice widely. Stone lay in the diverticulum and measured about 1 x 2 cm. in size. An incision was made through the mucosa around the orifice of the diverticulum and the mucosa carefully separated by blunt and sharp dissection and the sac withdrawn into the bladder in one piece; extravesical drainage of diverticular cavity; intravesical closure of orifice.

Pathologic report: The wall of the diverticulum varies from 5 to 8 mm. in thickness and consists of inflamed mucous membrane, fibrous tissue and some muscle; microscope shows abun-

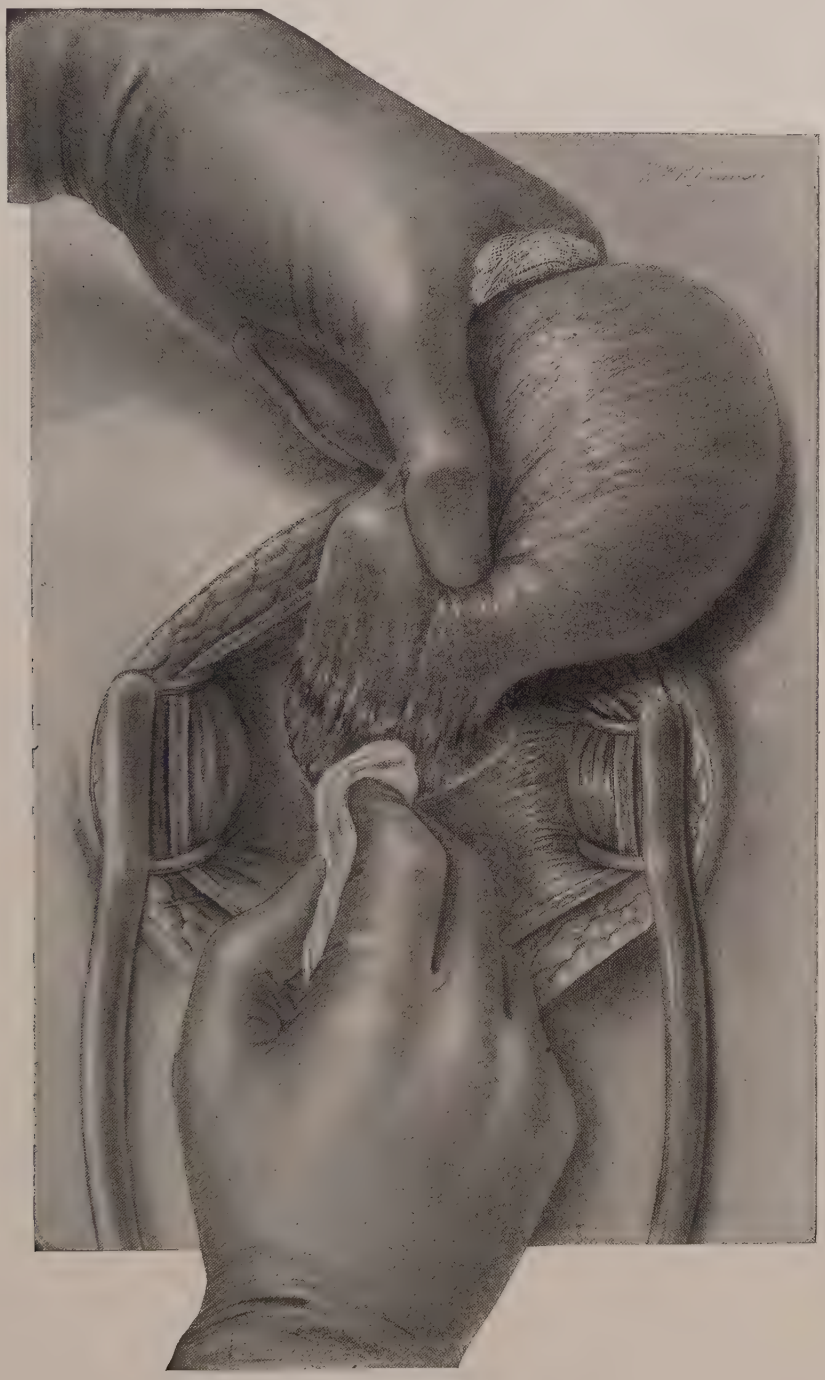


Fig. 737.—Intravesical diverticulectomy. The everted sac has been partly filled with gauze to assist in its enucleation. B. U. I. 10,125.

dant round-cell infiltration and some muscle fibers. Prostatic sections show definite prostatic hypertrophy.

Convalescence: Suprapubic sinus closed in thirty days; patient voided naturally, but with slight difficulty, at intervals of three to four hours. *x*-Ray shows a shadow, probably calculus, in the left ureter, which is dilated above it; this shadow was evidently obscured by the stone in the diverticulum on the left side and not recognized either before or at operation (Figs. 41, 42). Patient left hospital in good condition; has not returned for second operation; no subsequent report.

Vesical diverticulum many times larger than bladder; intravesical enucleation with assistance of finger externally.

B. U. I. 10,125, E. E. K., age forty-nine. Admitted November 8, 1921, complaining of difficulty in passing water. This had been present for about twenty-five years, gradually increasing in severity. Has noted, for past two or three years, the presence of an abdominal tumor. There was also pain in right inguinal region. Cystoscopy was done in dispensary, at which time 1600 c.c. of urine was withdrawn from bladder. Examination was unsatisfactory at this time on account of large quantity of pus and mucus in bladder. About 800 c.c. irrigation introduced and when it was decided to wash out bladder second time this irrigation fluid could not be recovered. The possibility that rupture of bladder had been produced was considered and patient was admitted to the hospital. No symptoms of rupture of bladder developed and two further examinations were made. Findings were very difficult to interpret since the instruments inserted were all deflected strongly to the right and catheters would find only a small quantity, about 150 c.c., of urine. If a retention catheter were left in, however, the abdominal tumor would gradually disappear. A good cystogram was finally obtained which showed a rounded mass in the location of the bladder, and a smaller irregular mass low down on the right side (Fig. 36). This picture was difficult to interpret and it was finally felt that it represented a large dilated bladder with small diverticulum on right side. December 2, 1921: Operation, Young. It was found that the small mass low down on right side represented bladder, whereas the large mass on left side was an enormous diverticulum, the orifice of which was just external to the left ureter and about 2 cm. in diameter. The diverticulum was dissected away (Figs. 735–737).

Convalescence following this operation was favorable. Tube was left in bladder seven days in order to allow bladder and diverticular cavity to close in. Following removal of tube, suprapubic fistula closed slowly and it was necessary to place a retention catheter to facilitate the closure. Sinus finally closed fifty-nine days after operation. At time of discharge patient voided freely without pain, through the urethra, every one or two hours during the day and only twice at night. As much as 500 c.c. could be voided at one time. Stereoscopic cystogram was taken and showed that the bladder was in good condition, although still showing some slight irregularity with appearance of trabeculation. Urine still infected, containing pus, cocci, and bacilli. Phthalein: Appearance time eleven minutes, 55 per cent. in two hours. The very small shadow cast by the bladder was no doubt due to the bladder emptying itself, whenever it contracted, into the enormous diverticulum.

Results.—Table 157, page 357, summarizes the results in 40 cases operated on for diverticulum of the bladder in our clinic.

CURETTAGE OF THE BLADDER

Curettage of the bladder is carried out for ulcerations, localized tuberculosis (rarely), adherent stones, etc. After the bladder has been exposed through an adequate suprapubic wound, the region is inspected and then curetted by means of an appropriate curet. In case of chronic ulcer of the bladder, it is wise to go fairly deep so as to remove all necrotic or infiltrated tissue and obtain a healthy wound for healing. Undermined edges may at the same time be excised by scissors or a knife.

CAUTERIZATION OF THE BLADDER

Cauterization of the bladder is applicable to the very similar conditions of the bladder and prostate. It may be done either with the electro- or the Pacquelin cautery. An appropriate cautery point should be chosen, and the instrument employed at a red heat. If a white or incandescent heat is employed marked hemor-

TABLE 157

DIVERTICULECTOMY

Type of operation.	Number of diverticula present, cases.						Results.				
	1.	2.	3.	4.	5.	6.	Died in hospital.	Well.	Unimproved.	Not followed.	Total cases.
Intravesical removal..... Suction used. Extravesical drain. Ureter not in diverticulum.	8	3	..	3	..	1	2	10	2[1, 2]	1	15
Intravesical removal..... Suction used. Extravesical drain. Ureter in diverticulum.	1	..	..	..	..	..	..	1	..	..	1
Intravesical removal..... Suction not used. Extravesical drain. Ureter not in diverticulum.	7	3	1	..	..	..	..	9	1[3]	1	11
Intravesical removal..... Suction not used. Transvesical drain.	3	1	..	..	..	..	..	3	..	1	4
Intravesical removal..... Suction not used. No drain. Ureter in diverticulum.	1	..	..	..	..	..	..	1[4]	..	..	1
Extravesical removal	3	..	..	..	..	..	..	3	..	..	3
Intravesical (1 div.) and Extravesical (1 div.) removal..... Extravesical perineal drain. Ureter in diverticulum.	..	1	..	..	..	..	..	1[5]	..	..	1
Mouth of diverticulum split through perineal wound....	2	..	..	..	..	..	1[6]	1	..	..	2
Mouth of diverticulum split through bladder.....	..	1	..	..	..	..	..	..	1[7]	..	1
Diverticulum marsupialized into bladder	1	..	..	..	..	..	..	..	..	1	1
Total cases	26	9	1	3	0	1	3	29	4	4	40

[1] Symptoms remained due to other diverticula not excised.
[2] Tuberculosis of kidney found later.
[3] Carcinoma in diverticulum. Died of metastases four months later.
[4] Had perivesical extravasation due to absence of drain, but recovered, with good result.
[5] Well for ten years, then died of cancer of the bladder.
[6] Died of postoperative extravasation.
[7] Slightly improved.

In every case operative removal of the obstructive element was undertaken by prostatectomy or punch.

Summary: Well, 29—72 per cent.
Unimproved, 4—10 per cent.
Died in hospital, 3—7.5 per cent.
Not followed, 4—10 per cent.

rhage may sometimes be encountered. In carrying out cauterization one must be careful not to burn too deeply and to remember that it is possible to destroy all the coats of the bladder, including the peritoneum, if too great and prolonged burning is carried out. Cauterization is also applicable for bleeding points in the bladder (varices, etc.), or hemorrhagic cystitis with pronounced areas of bleeding. We have recently seen a case of very early neoplasm of the bladder in which the patient was almost exsanguinated from continuous bleeding. Simple cauterization will arrest these at once. (The same thing can often be accomplished by fulguration through a ureter catheter cystoscope, the technic of which is described elsewhere.)

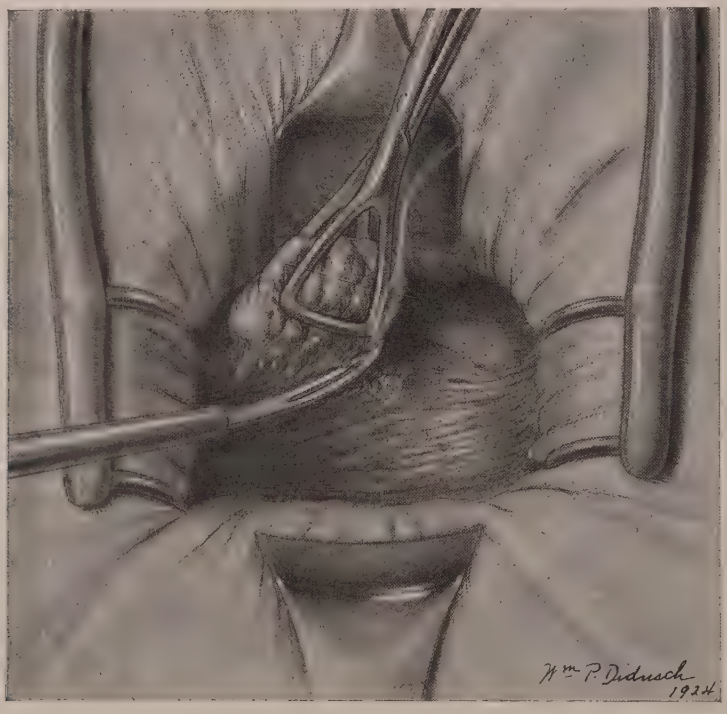


Fig. 738.—Excision of vesical tumor with electrocautery preparatory to implantation of radium. Note protection of wound with gauze to prevent implantation.

The most important use of the cautery within the bladder is for neoplasms, particularly those which involve the bladder in a region where complete resection is impossible, or contraindicated (Fig. 738). In such cases cauterization should not only include the base of the tumor but also the adjacent mucous membrane so as to include an apparently healthy wide margin around the tumor. Where the base of the tumor involves the orifice of the ureter one must remember that the sphincter of the ureter will probably be destroyed and that the danger of ascending infection of the kidney may be increased. Here again one is cautioned not to burn too deeply, but preferably to employ radium implantations in the depths of the wound after satisfactory cauterization has been carried out. Cauterization within the bladder is often employed to divide markedly elevated trigonal hypertrophies, prostatic bars, or other irregularities, polyps, cysts, etc., at the prostatic

orifice or within the prostatic urethra. It may also be used for valves of the posterior urethra which are not infrequently seen in children.

Linear cauterization may also be employed to extract a stone incarcerated in the intravesical or intramural portion of the ureter, or to divide strictures in that region. It has been popularly used in the excision of pedunculated tumors of the bladder, as described elsewhere. Modern electrical devices such as the so-called "endotherm knife" remove tissue without burning deeply, and may eventually replace the actual cautery for a certain proportion of this work.

Following cauterization some form of vesical drainage is usually employed. It is well to use a mushroom drain which is fastened into the upper angle of the bladder wound, as described elsewhere. During convalescence antiseptic injections or irrigations to combat infection are very desirable. This is particularly true after cauterization, since dead tissue forms an excellent nidus for the development of bacteria.

EXCISION OF THE BLADDER WALL

Excision of a portion of the bladder wall is carried out within the bladder for conditions very similar to those previously described. In *ulcers* it is usually wise to

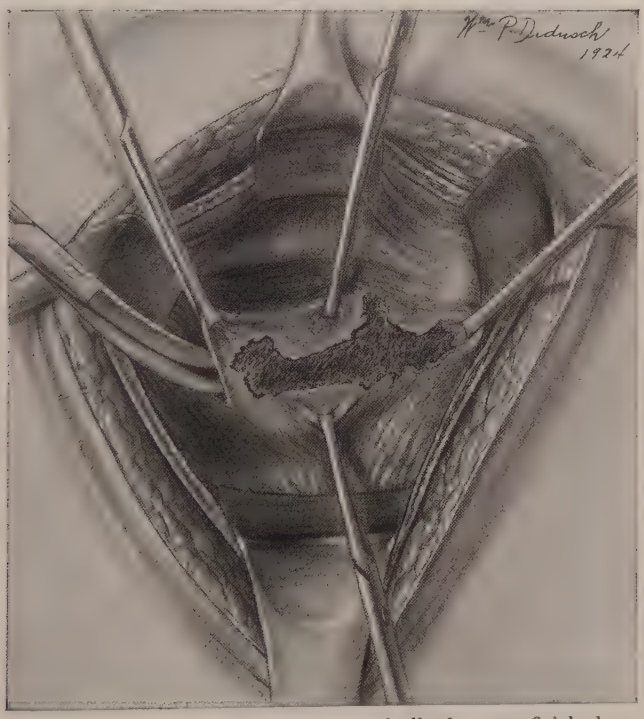


FIG. 739.—Resection of mucosa and submucosa intravesically for superficial ulcer of bladder. This technic is applicable also for interstitial or submucous cystitis. Musculosa is not resected.

insert cardinal stitches or Allis clamps at various places through the healthy tissue external to the ulcer. These are employed not only to raise up the tissues, but to indicate to the operator the extent of excision necessary. This is very important, as hemorrhage is very apt to obscure the wound. Either scissors or knife may be employed and care should be taken not to penetrate too deeply the coats of the bladder, or to injure important structures such as ureter, peritoneum, etc.

Where examination of the lesion within the bladder seems to indicate that it is not very deep, as in submucous cystitis, this method of partial excision of the bladder wall may be carried out with success. As shown in Fig. 739, the inflammatory area is removed with a fairly wide margin. The wound does not penetrate the outer coat of the bladder, and may be completely closed by a line of plain catgut sutures.

An excision of this character has been very frequently employed in benign papillomata of the bladder, but the results obtained have not been satisfactory. Despite every effort to remove the tumor with a wide area of healthy mucous membrane, recurrences were frequent. This is true even when the greatest care was taken not to touch the tumor or to break off any villi which might be implanted in the line of excision or in the suprapubic wound. On this account fulguration through a ureter catheter cystoscope and the use of radium have become methods of choice, and have caused excision to fall into disuse.

RESECTION OF THE BLADDER WALL

This term indicates an operation in which the entire thickness of the bladder wall is removed. It is employed in cases of interstitial cystitis in which the whole bladder wall is involved, in deep chronic ulcers of the bladder, in infiltrating carcinomata or malignant papillomata where it is essential that the tumor should be removed with a wide healthy area. In describing the technic it is well to discuss the operation according to the region of the bladder attacked.

Anterior Wall.—Where the area to be resected lies on the anterior wall of the bladder, it is well before operation to map out as accurately as possible the region involved and area to be removed. An extensive suprapubic median line incision should be carried out in order to get wide retraction and excellent exposure.

Some authors advise a transverse incision with division of the recti muscles, but we have not found this necessary, and there is much to be said against it. Where the line of excision is to run close to the vertex, it may be wise to divide the urachus at its junction with the bladder and to separate the peritoneum from the posterior wall of the bladder for a sufficient distance. The bladder which has been previously filled with air is then very carefully palpated and the area of induration mapped out. At this juncture Hagner advises the use of a cystoscope, under the guidance of which needles or pins can be inserted from within through the bladder wall around the periphery of the tumor and thus act as guiding points for a radical resection.

The procedure which we usually follow is to locate the tumor mass, find an area of apparently healthy bladder, either above or on either side, and to make a stab wound into the bladder at this point. Grasping the edges of the wound with Allis clamps, it is enlarged with scissors, and the part containing the tumor drawn outward for careful inspection, retractors being inserted into the rest of the bladder so that the operator may get an accurate view of the region involved. With scissors or knife the excision is carried out with as wide a margin as possible (Fig. 740). Not infrequently the entire anterior wall and vertex of the bladder may be thus removed. Occasionally it may be necessary to extend the incision down to or into the prostate. Bleeding points must be carefully caught and ligated, and great care must be taken not to allow the surface of the tumor to touch the wound. Likewise tumor fragments must not be broken off or allowed to drop into the bladder or prevesical space.

If the tumor extends close to the prostatic orifice it is usually wise to use cautery to burn deeply into the prostate, and then to plant radium into the deeper adjacent tissues. Where the tumor mass is adherent to the perivesical structures, *e. g.*, symphysis pubis, etc., cauterization and radium should be employed. Before closing the bladder the prostatic orifice should be carefully examined and bars or contractures carefully divided or cauterized. Intra-urethral polyps should also be looked for and destroyed as they are frequently malignant implantations from the original tumor.

Resection of the Lateral Walls of the Bladder.—The technic employed here is much the same as that for the anterior wall. The tumor should be carefully located before opening the bladder in a healthy place, and the resection made as radically as possible. If the operator finds that the resection must extend well backward, it may be desirable to clamp, divide, and ligate the blood-vessels run-

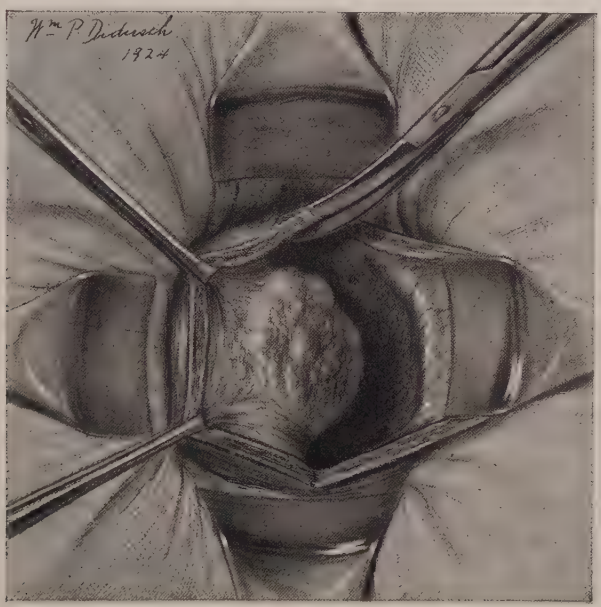


Fig. 740.—Resection of bladder for tumor of anterior wall. Wound protected by covering of gauze.

ning to the bladder externally in the region involved—the superior and middle vesical arteries (Fig. 741). If this is not done, considerable hemorrhage may be encountered. In all resections of the bladder, before closure, the interior should be treated with 95 per cent. alcohol or 20 per cent. resorcin in order to destroy any tumor fragments which may have been left behind.

The closure of defects left by extensive resections of the bladder requires much plastic ingenuity. In some cases it may be possible to use a single longitudinal or transverse line of closure, the muscle and mucous membrane being drawn together by a continuous chromicized catgut suture, and drainage provided in the median line as near the vertex as possible. (Sometimes through a stab wound.) Often the muscles will come together in the shape of a Y, or sometimes in a more irregular form. It is often necessary to draw one portion of the bladder over to a part quite remote in order to close the viscus, but it is amazing that, after such

distortions, an excellent functioning bladder may be obtained and ultimately a splendid capacity.

Vertex of the Bladder and Upper Posterior Wall.—1. *Extraperitoneal Resection.*—The peritoneum is pushed upward as far as possible and freed from the bladder until the urachus is exposed. Transverse incision is then made at the vesico-urachal juncture. Great care is necessary here to avoid tearing into the peritoneal cavity. Below this point the peritoneum may be stripped off from the posterior surface of the bladder fairly easily (Fig. 741), and, as pointed out in 1900,[1] the bladder can thus be freed from the peritoneum until the blunt dissection passes the pouch of Douglas, and exposes the seminal vesicles, vasa deferentia, and ureters. Having freed the bladder beyond the area of palpable induration, the bladder (previously filled with air) is then opened well down on the anterior wall remote from

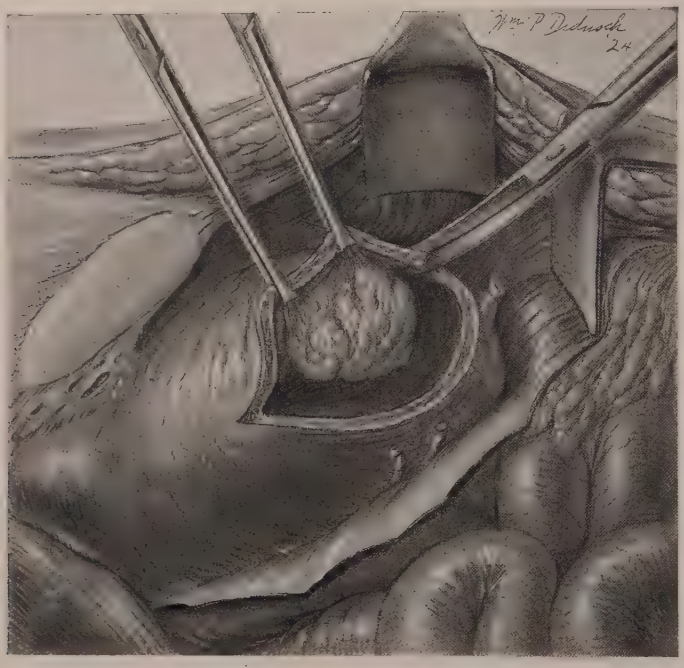


FIG. 741.—Extravesical resection of tumor of lateral wall of bladder. The urachus has been divided, the peritoneum pushed backward, the lateral vessels of bladder ligated and divided. (Semidiagrammatic sectional view.)

the tumor by a transverse incision, which is rapidly enlarged on each side, and the edges raised with Allis clamps. The operator then carefully inspects the area to be resected, places clamps or cardinal stitches to map out the line of incision, and proceeds to remove the mass in one piece, care being taken as stated before to avoid implantations, etc. Here again it is well to ligate the superior and, if necessary, middle vesical arteries before beginning to resect. Peritoneal tears may be closed at once with continuous plain catgut. The defect left in the bladder wall is closed either in transverse, vertical, Y, or irregular lines as may be found best.

2. *Intraperitoneal Resection.*—In many cases tumors in the vertex of the bladder involve the peritoneum or are so close to it that it is advisable to resect it with the bladder wall. This, if possible, should be determined before the bladder is opened,

[1] Young: Annals of Surgery, 1900, xxxii, 557–566.

and, if in doubt, the operator may with impunity make a median incision into the peritoneal cavity, above the bladder, for inspection or palpation with the finger. Still again the operator may decide, rather than attempt a difficult dissection of the peritoneum from the posterior wall of the bladder, to do a transperitoneal operation. Having opened the peritoneum, it should be widely retracted and incisions made obliquely on each side at the vesicoperitoneal reflection so as to obtain a good exposure.

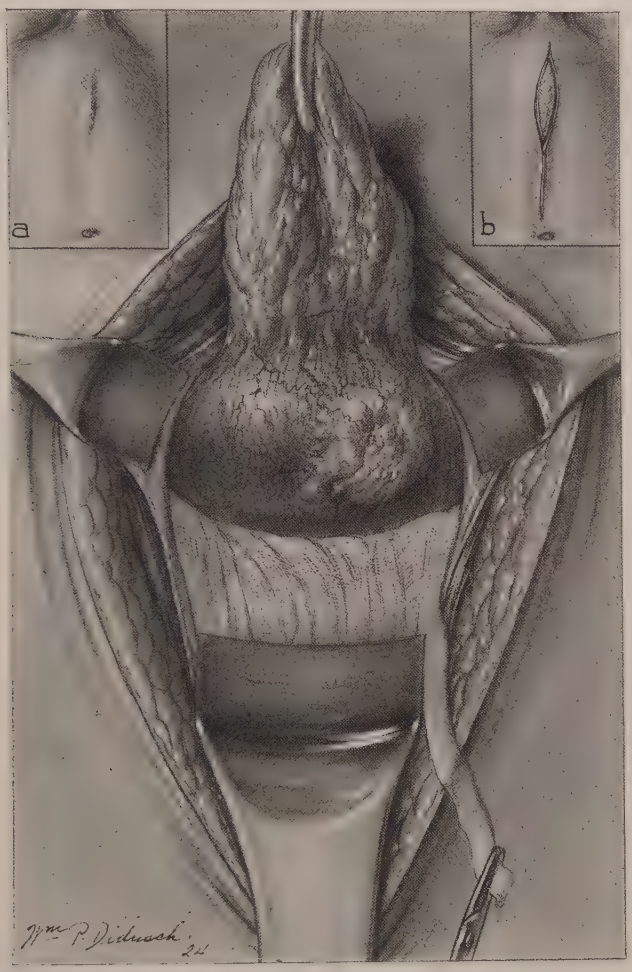


FIG. 742.—Tumor of bladder occurring in suprapubic lithotomy wound. *a*, Suprapubic scar elevated and indurated. *b*, Line of incision. Large figure shows peritoneum opened, posterior wall of bladder with tumor beneath, suprapubic scar partly excised above. B. U. I. 6077.

The tumor should be mapped out and the line of radical excision determined (marked with stitches or clips). Having packed off the peritoneal cavity with Mikulicz pads, the incision is then made into the anterior wall of the bladder at a part surely remote from the tumor, and generally transversely. With the wound enlarged and the edges picked up, careful examination of the area involved is made and, if advisable, needles or pins passed through into the peritoneal cavity so as to demarcate the line of operation. Resection is then carried out as previously described, the peritoneal coat being included.

In the closure of the defect much depends upon the extent of the excision. Where the musculoperitoneal area excised is not excessive, and peritoneum is still present attached to the remaining bladder wall on each side, it may be possible to approximate the walls so as to invert the peritoneum and bring the surfaces together and then close the mucous membrane of the bladder within by a continuous

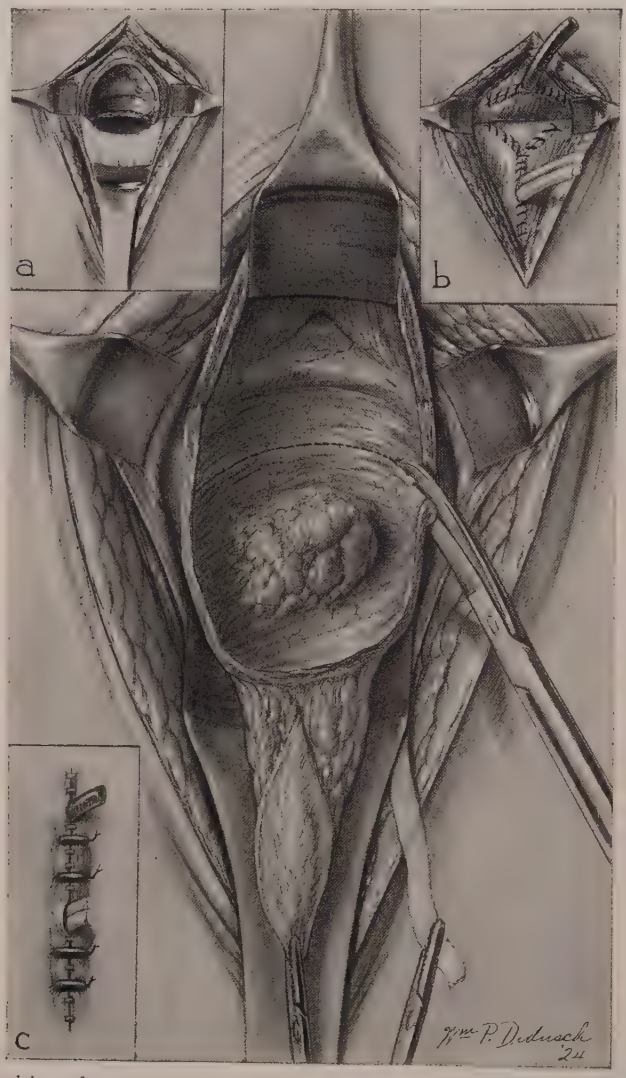


Fig. 743.—Excision of tumor of bladder transperitoneally: *a*, Condition left after resection. *b*, Showing transverse closure of bladder, and Y-shaped closure of peritoneum. *c*, Closure of abdominal wall with drainage. B. U. I. 6077.

catgut reinforcing suture. The technic of extensive intraperitoneal resection of the bladder for tumor is shown in Figs. 742 and 743.

Where resection has been extensive one generally finds that the peritoneum and bladder wall have become separated. It is then usually adviasble to close the peritoneum first with a continuous plain catgut suture. Difficulty will usually be experienced in drawing it together from side to side so as to form a vertical line of

closure. Generally it may be drawn up and closed in the form of an inverted T or Y. We have never seen any case in which by freeing the peritoneum on each side from deep lateral adhesions it could not eventually be drawn together and completely closed with a continuous plain catgut suture, which brought the serous surfaces together (see Fig. 743, *b*). The bladder is then closed with a continuous chromic catgut suture placed from without.

Drainage, in operations upon the vertex of the bladder, either intra- or extraperitoneal, should comprise: (1) Vesical suprapubic drainage with de Pezzer catheter; (2) tube or cigarette drainage for each posterolateral extravesical region.

Where the peritoneum has been opened, and not very effectually closed, a peritoneal drainage-tube may be inserted, but it is rarely necessary. If the operator has been unable to close the peritoneum, a fairly wide gauze drain with protective on the surface may be employed until adhesions close off the peritoneal cavity.

The impunity with which the peritoneum can be entered in these cases is extraordinary. One objection to transperitoneal operations upon tumors of the bladder has been the occurrence of intraperitoneal recurrences or implantations. We have generally found it possible to do the operation extraperitoneally, but in those rare instances in which the transperitoneal technic has been followed, good results have been obtained.

Base of Bladder.—Excisions of this portion of the bladder include the region of the deep posterior and lateral walls back of the trigone and ureteral ridges. Here again the operation may be extraperitoneal or intraperitoneal, depending on the extent of involvement and the difficulty of approach. In most cases the bladder is opened through an anterior median incision, and by wide retraction an adequate exposure is obtained. The extent of resection is determined upon and the bladder freed externally on one or both sides, the arteries being isolated, clamped, and divided. By blunt dissection the bladder wall is separated from adjacent structures—peritoneum, rectum, vas deferens, seminal vesicles, and ureters. In most cases it is advisable to insert catheters into the ureters so as to facilitate their extravesical identification. The resection is then carried out with either scissors or electrocautery. Care is taken to be as radical as possible, but not to divide the ureters unless necessary. Ingenuity in plastic closure of the defect may, again, be required, the line of suture being placed either from within the bladder or externally, as may be most convenient. The peritoneum is closed, if it has been opened, as previously described.

Trigonal Region.—Where a malignant tumor involves the trigone or ureteral orifices *transplantation of the ureter* is generally indicated. In such cases the line of exposure may be either intravesical or extravesical, depending on the extent of involvement, and the operative procedure necessary. Where the intravesical technic is attempted, after careful inspection, study of the tumor and location of proposed line of resection, ureteral catheterization should be carried out if possible. Resection is done either with scissors or preferably with red hot cautery, care being taken to catch and ligate bleeding points, which are apt to be very numerous. Having penetrated the bladder, externally to the ureter, one may usually locate by palpation or vision the ureter in its course back of the bladder, and catch it up upon a tape while the rest of the resection is carried out. Making traction upon the mass, one may then seize the ureter, divide it, and transplant it into the

upper angle of the wound. If more suitable, a stab wound may be made and the ureter drawn through and held there within the bladder by one or two fixation stitches of plain catgut. It is well also to place one or two sutures through the ureteral sheath and the bladder posteriorly so as to prevent retraction. Plastic closure is effected, and suprapubic drainage afforded. In rare instances the operator may feel it advisable to remove the adjacent portion of the seminal vesicle, ampulla, or a portion of prostate, but in our experience nothing is gained in these cases by such radical operations. Cauterization and use of radium are, as a rule, much to be preferred in infiltrating tumors of the region of the trigone and base of the bladder.

In tumors of the trigone where the base and lateral wall of the bladder are also involved, an extravesical exposure, in which the blood-vessels are recognized, clamped, cut, and ligated and the ureter isolated before opening the bladder, is sometimes advisable. By such procedure the ureter may be easily located, particularly if it has been previously catheterized. It should then be held up upon a tape and incision made in the lateral wall of the bladder sufficiently remote from the tumor. With the bladder well exposed, the resection is carried out as widely as is necessary, including a portion of the trigone, base of bladder, and ureter. Squier has done very radical operations of this nature upon tumors of the bladder, reporting numerous hemisections and also cases in which even more extensive resections have been carried out. The mortality of such procedures varies from 25 to 40 per cent. and they are, in our opinion, not often justifiable, in view of the excellent results which are frequently obtained by cauterization, radium, and *x*-ray in tumors of the bladder in this region.

SUBTOTAL CYSTECTOMY

Subtotal cystectomy was necessary in one of our cases in which the vertex, lateral and posterior walls of the bladder were involved in a very extensive malignant tumor. Urination was frequent and so painful that suprapubic drainage was afforded. There was no relief from this, however, and the patient continued to suffer from severe spasmodic pain in the bladder. We performed a laparotomy, and after ligating the vesical arteries on both sides removed the entire bladder with the exception of the trigone which was left attached to the prostate. The intestines were walled off with gauze, and the pelvic wound packed and drained. The object of the operation was obtained, in that pain was relieved. The urine escaped through the wound, but the patient was more comfortable while he lived.

TOTAL CYSTECTOMY

This operation has been advised for extensive tumors of the bladder. A few cases in which it has been done are to be found in the literature. We have personally never done this operation. The technic is thus described by Albarran[1]:

A. Operation in a male, not including the prostate.

First stage: Derivation of the course of the urine by lumbar nephrostomy or ureterostomy.

Second stage: 1. Preparation of bladder—insertion of 200 c.c. of liquid to facilitate the separation of peritoneum. One should leave a catheter in the bladder to evacuate the liquid subsequently.

[1] Médecine Opératoire des Voies Urinaires, 1909, Paris.

2. Incision of the perineum and separation of rectum from bladder. With the patient in position for prostatectomy the usual perineal incision is made, the prostate exposed, and separated from the rectum. Blunt dissection is carried upward until the seminal vesicles and posterior surface of the bladder are also freed. Subsequently drainage is afforded through this space in the perineum.

3. Transverse suprapubic incision. With the patient in the Trendelenburg position, the bladder is exposed through a transverse incision through the skin and abdominal muscles. The recti muscles should be caught with sutures so as to facilitate their subsequent discovery for closure. If the space is insufficient, one may also make a median incision above (inverted T).

4. Separation of peritoneum and mobilization of bladder. This is carried out as previously described, the arteries being carefully ligated. If the peritoneum is closely attached it may be opened without hesitation and subsequently closed. No difficulty is usually experienced in completely freeing the bladder from the peritoneum.

5. Section of the pubovesical ligaments. In carrying this out it is well to draw forcibly upon the bladder and divide the ligaments between clamps, carefully ligating to stop bleeding points or inserting packs beneath the retractors.

6. Section of the ureters and lateral pedicles of the bladder. Drawing the bladder forcibly toward the left, the surgeon will discover the right ureter and the lateral inferior vascular pedicle. The ureter is sectioned and ligated, and the vascular pedicle clamped, cut, and ligated near the bladder. In a similar manner the left ureter and vascular pedicle are attacked.

7. Division of the vesical neck. The summit of the bladder is forcibly seized with traction forceps introduced through the perineal wound. One makes traction to revolve the bladder from front to rear, as if one wished to draw it out through the perineum. This maneuver exposes well the anterior part of the vesical neck which one divides in front in the region of the vesical orifice of the urethra. The bladder, completely freed, is then removed by the abdominal wound.

8. Drainage and suture of the wound. All hemorrhage should be stopped. If necessary, clamps may be left in place for forty-eight hours. A large drain is placed in the perineum and another in the suprapubic region, and the rest of the wound above and below is closed through approximation of muscles.

B. Extirpation of the Bladder and Prostate.—For this operation Albarran suggested the technic, as above described, except that the prostate is freed from its attachments, both fibrous and vascular, and the membranous urethra divided, after which the prostate and entire bladder are removed *en bloc*. The operation has also been carried out without a perineal wound, but, according to Albarran, it is much more difficult, and he advises strongly liberating the prostate by the perineum before attempting to carry out cystectomy suprapubically.

Mann and Kossinsky have carried out transperitoneal total cystectomy. Operations of total cystectomy in women are less difficult than in men and the technic may be entirely abdominal, or abdominovaginal.

Comment.—We have never felt justified in carrying out an operation of total cystectomy. In cases of multiple benign vesical tumors, for which it has been employed by some operators, endovesical fulguration and radiation are sufficient for a cure. Where a malignant tumor is so extensive as to require cystectomy for its removal, one may be certain that metastasis has already occurred. A careful

study of the literature shows, in our opinion, that the high mortality and the rarity of success render this operation thoroughly unjustifiable.

OPERATIONS ON THE TRIGONE

In our experience the trigone has required operative attack for two conditions—*hypertrophy* or *bar formation*, and *autodissection of the trigone* in tuberculosis. As remarked elsewhere, the trigone is hypertrophied in cases of prostatic obstruction. This hypertrophy is due, as we have shown, to the increased effort which devolves upon the trigone in pulling down the median portion of the prostate to open the urethra for urination in cases of obstruction at the vesical orifice. During supra-

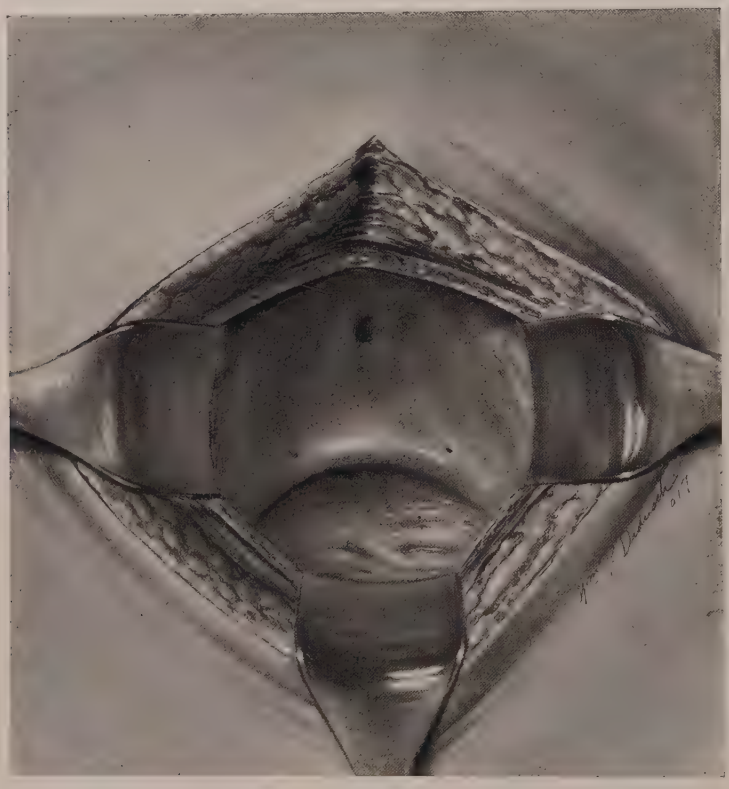


Fig. 744.—Man aged forty-three years; complete retention of urine, residual 1100 c.c. Median prostatic bar removed by punch operation. Suprapubic operation to remove trigonal bar. Appearance at operation. Trigone hypertrophied, elevated, with deep pouch behind it. B. U. I. 5533.

pubic prostatectomy one frequently finds the ligamentum interuretericum, which forms the posterior limit of the trigone, markedly elevated, with a pouch behind it. The rest of the trigone is usually shortened, thickened, and drawn up toward the prostatic orifice. In some cases the trigonal hypertrophy and elevation are very great and the pouch behind it may form the larger part of the vesical cavity. In one case, operated upon by us in 1904, the trigone rose up as a great thick bar 2 inches high and 1 inch thick, immediately behind the prostatic orifice (Fig. 744), completely blocking urination. In this case we divided the trigone completely in the median line, as shown in Fig. 745, and after excising a portion on each side, sutured the edges so as to approximate the mucous membrane (Fig.

746), as first described by us[1] in 1911. This put the bottom of the pouch practically on a level with the urethral orifice and completely removed the obstruction to urination. In 1 case we did a punch operation upon a trigonal bar which was present. Since then we have carried out this procedure on several cases in which the trigone was less markedly enlarged and elevated. In a few instances the hypertrophied trigone was caught and divided by a specially constructed trigonotome (Fig. 747), and in another case with our "punch." Such endovesical division of the trigone, however, is not usually satisfactory. The hemorrhage is apt to be considerable. It is possible to penetrate to the perivesical space and extravasation might result. Suprapubic operation is, therefore, usually indicated when operative

FIG. 745.—Hypertrophied trigone has been divided and a wedge-shaped piece excised to bottom of pouch. Suture commenced. B. U. I. 5533.

attack is necessary. We feel now, however, that this is rarely the case, that hypertrophied trigones generally atrophy when the obstruction to urination is relieved, and the muscles of the trigone no longer have to exert abnormal force to open the vesical orifice.

We have reported in the above-mentioned article an interesting series of cases in which the trigone was markedly changed as a result of tuberculosis of the kidney and bladder. In some instances the trigone is completely separated from the bladder except at the three corners—ureteral ridges and prostatic orifice—forming a

[1] Young: Transactions of the International Association of Urology, Second International Congress, London, 1911. Also described by Young and Wesson: Archives of Surgery, 1921, iii, 1–37.

bridge across the floor of the bladder. In 2 cases this was associated with great vesical irritation and operative removal was carried out—in 1 case through a

FIG. 746.—Bilateral wounds of trigone closed with continuous catgut suture, thus removing bar and obliterating pouch. These two operations did not afford complete evacuation of bladder. A second punch operation was required and was followed by cure.

suprapubic incision and in the other by means of cystoscopic instrumentation. In the latter case the corners of the floating trigone were divided by fulguration

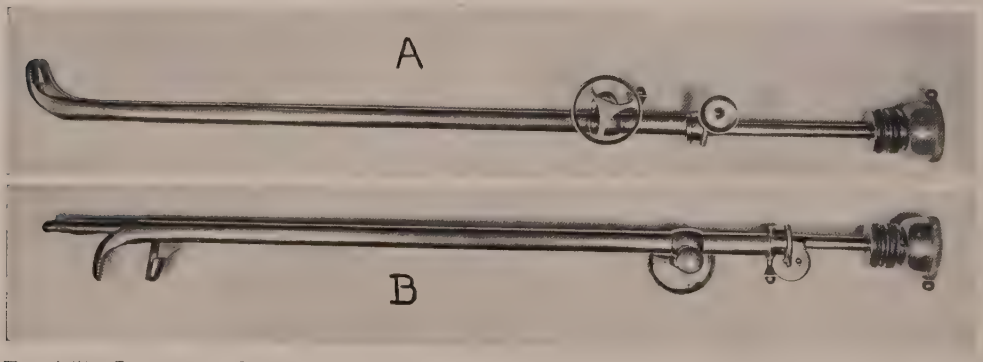


FIG. 747.—Instrument devised to divide hypertrophied trigone ("cystoscopic trigonotome"). A, Closed. B, Opened and turned down for grasping trigone.

(see Fig. 748), after which it was picked up in the jaws of the cystoscopic rongeur and removed from the bladder, practically without hemorrhage. No similar cases

have been found in the literature. T. N. Hepburn[1] has recently presented an article on spastic obstruction to the ureters which he thinks is due to spasm and hypertrophy of the trigone, for which he recommends division of the trigone as described above.

OPERATIONS FOR HOUR-GLASS BLADDER

This condition is one in which the bladder is circularly constricted and divided into two portions with a narrow canal of communication, as in an hour-glass. In our experience we have met with two types of lesion—one in which the trigone participated in the constricting circle, the cavity in front being much smaller than that behind. In 1 such case, after dividing the constriction anteriorly, we also carried out division of the elevated, hypertrophied trigone posteriorly. The mucous edges of the wound were closed by sutures on each side and the constriction relieved. In this case a median prostatic bar was present and was destroyed by cautery, with excellent result. In another case the circle of contracture passed across the posterior wall of the bladder at least an inch behind the trigone. The

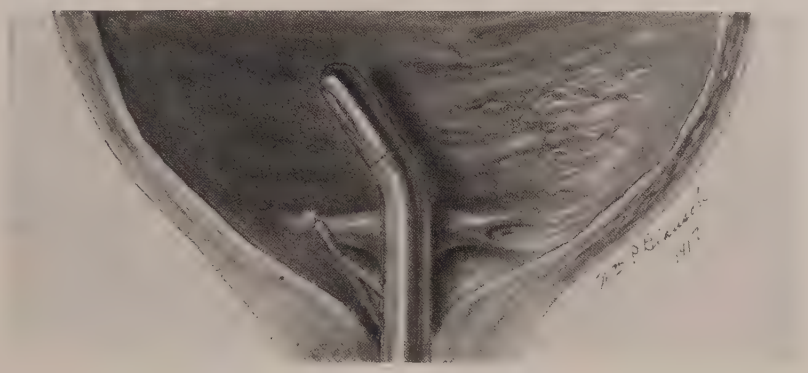


Fig. 748.—Renal tuberculosis; vesical tuberculosis undermining trigone which was attached only at the three corners. Trigone removed by dividing attachments by fulguration. Loose trigone then removed with cystoscopic rongeur. B. U. I. 3565. See Archives of Surgery, 1921, iii, 1–37.

two portions of the bladder were more nearly equal in capacity. A similar division anterior and posterior with approximation of the mucous membrane along each cut surface was carried out. In most cases of hour-glass bladder there is a concomitant prostatic obstruction with hypertrophy or bar, which has led to either hypertrophy of the trigone, or marked trabeculation of the bladder. With the addition of chronic inflammation the hour-glass contracture has resulted.

Simple prostatectomy will probably be all that is necessary in many of these cases as atrophy of the trabeculations and trigone follows removal of the prostatic obstruction. The hour-glass deformity will often decrease or disappear, but in some cases it is so pronounced, or the contracting ring so marked, that operation will be required.

OPERATIONS FOR TRAUMATISM OF THE BLADDER

Injury of the bladder is so varied in its character and cause that the operative treatment will usually have to be suited to the conditions found present. A few broad principles may be laid down from experience.

[1] Annals of Surgery, 1925, 1133–1141.

Rupture of the Bladder Without External Wound.—As stated elsewhere, this not infrequently occurs in accidents where the body is crushed without rupture of the integument. Such ruptures are not infrequently due to the bladder being distended with urine, but in others the bladder is torn by bony fragments. The rupture may be either intra- or extraperitoneal and occasionally the rectum may also be torn. At times there is also rupture of the urethra, membranous, prostatic or bulbous, so that the necessary operations may be extremely complicated. Even

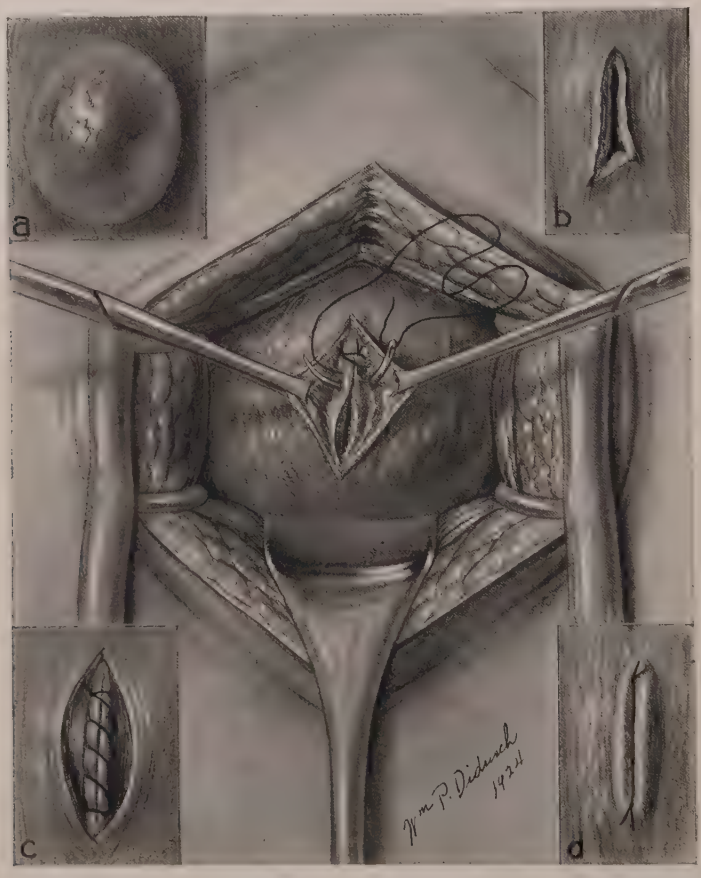


Fig. 749.—Vesical calculus. Litholapaxy. Instrumental rupture of bladder, partial in character, through mucosa and muscle. Extraperitoneal extravasation. Symptoms suggesting peritonitis. Laparotomy. Bleb on posterior wall of bladder (*a*) at site of rupture; *b*, incision of bleb exposing hole in bladder. *c*, Mucosa and muscle closed with continuous catgut suture. *d*, Peritoneum closed with continuous catgut suture approximating peritoneal surfaces. General peritonitis present though peritoneum was intact. Abdominal drainage, cure. B. U. I. 209.

where the tear through the bladder wall is small, it is not safe to depend on catheter drainage, but suprapubic operation should be carried out. Through a median incision the prevesical space is exposed and careful search for the point of rupture made. If found along the anterior or lateral walls of the bladder, immediate closure without opening the bladder may be carried out, after evacuating blood-clots. Where it is evident that *the rupture is intraperitoneal*, it may not be necessary to open the bladder (Fig. 749), but the wound may be closed through a transperitoneal incision which approximates the mucous membrane as well as the deeper structures.

A second reinforcing peritoneal line of catgut sutures may be employed. Drainage of the pelvic space with tube or cigarette drain may be carried out if desirable.

Where the operator is unable to discover the point of rupture, the bladder should be opened in the median line, clots removed, and the bladder carefully inspected. Inspection must be thorough, as a small punctured wound may be very hard to find. Spurting vessels should be caught and ligated, badly lacerated tissues excised, and the wound closed intravesically with continuous plain catgut sutures. If the ureter is involved or torn across, it should be taken care of by appropriate procedures. Where the wound extends into the prostate or membranous urethra, anastomosis may be required. Trauma of the bladder due to missiles is discussed later under Military Urology.

OPERATIONS FOR BLADDER FISTULÆ

Suprapubic Fistulæ, Vesicocutaneous.—These may be traumatic, postoperative, or due to prevesical abscess, tuberculosis, calculus, or malignant disease. The operative treatment depends upon the cause of the fistula and the conditions present. In those which follow traumatism or persist after suprapubic operation, one usually meets with a fistulous tract surrounded by fibrous tissue, the excision of which can usually be carried out without difficulty. In some cases simple curettage followed by urethral catheter drainage is sufficient to effect a cure. One must be sure that no urethral obstruction is present. When this does not succeed, excision of the fistula may be carried out. The operation should be done with care, owing to the fact that the bladder is usually contracted and the peritoneum is close to the fistulous tract, often immediately behind the symphysis pubis. The incision is usually a linear one, the center of which circumscribes the fistulous opening. The wall of the fistula may be dissected fully, but carefully, until one approaches the peritoneum. At that point it is usually wise to expose the anterior wall of the bladder below the fistulous tract and on each side, and to carry the dissection somewhat within the wall of the fistula posteriorly so as to avoid injury to the peritoneum. Occasionally the operator will find much assistance in splitting the fistula along its inferior aspect, opening the bladder, inserting the finger with which the bladder is drawn upward, and a careful dissection of the fistulous tract made (Fig. 750). If the peritoneum is accidentally incised or torn it should be sufficiently freed on each side so that it may be closed with a continuous catgut suture. After opening the bladder, a careful digital exploration should be made to determine whether any obstructive conditions are present which would tend to keep the fistula open. If contracture at the prostatic orifice or within the urethra or a hypertrophied prostatic lobe be found, the obstruction should be removed and the orifice sufficiently enlarged by incision, enucleation, cauterization, or the "punch" operation through the urethra to insure adequate urethral drainage.

If much intravesical hemorrhage is thus produced, it is not wise to attempt to close the anterior bladder wall. If the bladder is free from hemorrhage, one may sometimes close with continuous, chromicized catgut suture, perhaps using two layers so as to obtain broad apposition. It is well to provide urethral drainage by means of a retention catheter. The skin and recti muscles are then drawn together with interrupted sutures of silver wire, a small prevesical catheter drain emerging from the lower angle of the wound. This should be occasionally treated antiseptically (1 per cent. mercurochrome).

Subsequent Treatment.—A retention catheter is kept in the urethra for a week, then removed and replaced by a fresh catheter so as to avoid the accumulation of concretions upon the catheter. Urethral drainage is continued for another week, during which the bladder is generally injected with some mild antiseptic two or three times daily. Removal of the prevesical drain is safe four or five days after the operation.

Suprapubic fistulæ in cases of tuberculosis of the bladder have often proved very difficult to cure. One should first attack the tuberculous process in the bladder and attempt by lavage, injections, fulguration, and other well-known methods to effect a cure. When associated with *tuberculosis of the seminal vesicles or kidneys* radical excision, if feasible, of these affected organs should be carried out, after

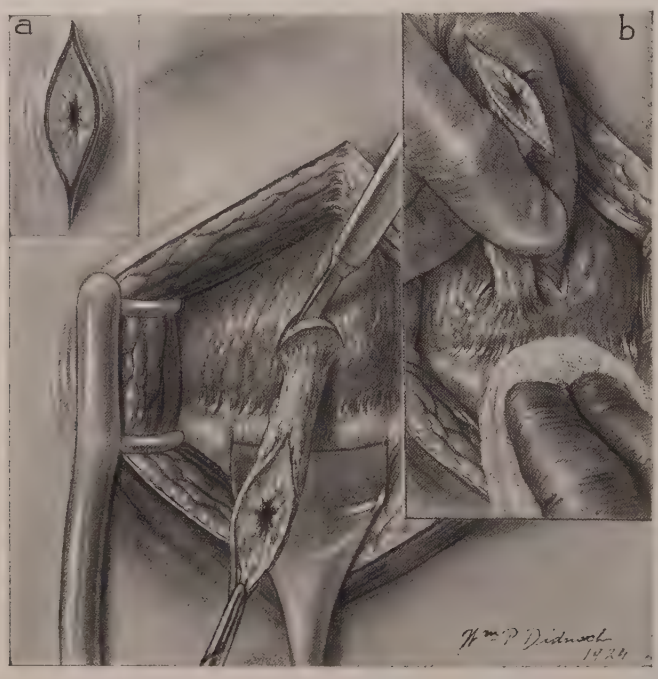


Fig. 750.—The excision of suprapubic urinary fistula. *a*, Skin incision. Main figure, exposure of bladder, cystotomy. *b*, Insertion of finger into bladder and excision of vesical end of fistulous tract.

which the vesical lesion will often heal. Occasionally tuberculosis of the bladder is associated with a fibrous contracture of the vesical orifice and in these we have found a cautery "punch" operation of value in facilitating a cure of the vesical lesion and promoting the closure of the suprapubic fistula.

As long as there is an active tuberculous process in the bladder (which can be made out by examination of the urine for tubercle bacilli or cystoscopy through the suprapubic wound, if not through the urethra), it is vain to attempt closure of the suprapubic wound by surgical excision. At all events, curettage and an in-lying urethral catheter should be attempted first.

When the bladder is free from tuberculosis, excision of the fistula and closure of the bladder wall may be attempted, as described above.

Suprapubic fistula associated with cancer of the bladder should be treated by

radium therapy. Excision is manifestly of no value as long as the malignant disease persists. The fistula sometimes closes when the obstruction is removed by a punch operation.

Inguinal Fistula.—The operative attack will depend upon the cause of the fistula and the route traversed. Fistulæ of the inguinal canal may result from traumatisms to the bladder, which may project into or be drawn into the inguinal canal and injured in operations for hernia. A filiform passed through the fistula can usually be seen with a cystoscope entering the bladder. Where the opening is distinctly lateral a suprapubic incision may be made through the rectus muscle, the bladder exposed, the fistulous tract freed, and the opening closed without entering the bladder cavity. A retention catheter is supplied and the suprapubic wound closed with a small prevesical drainage-tube.

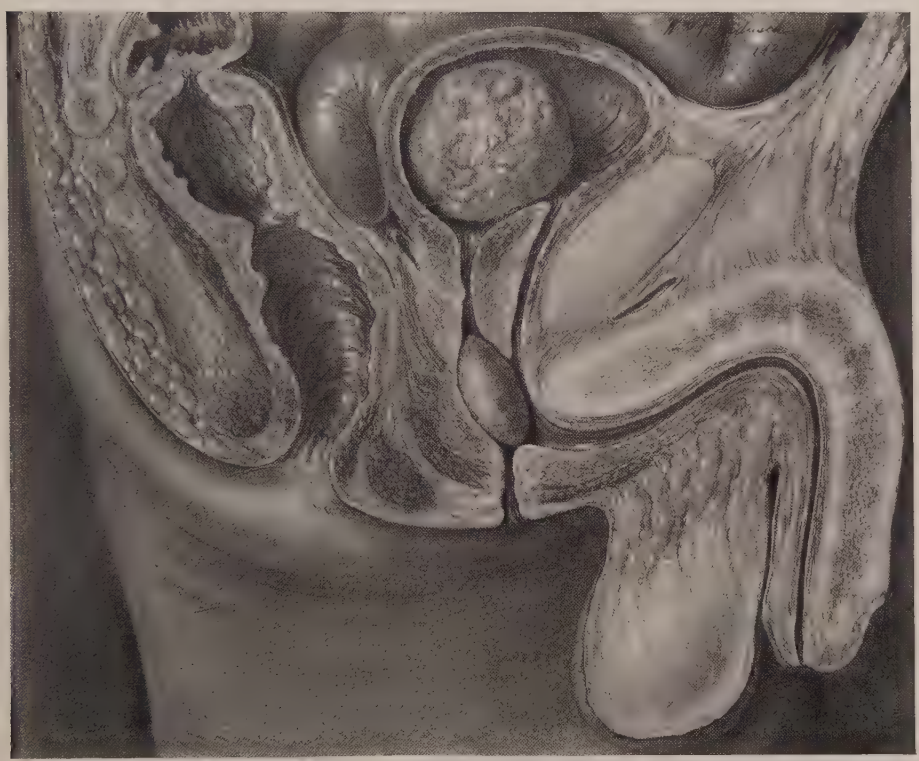


FIG. 751.—Man aged forty-two years. Automobile accident, fracture of pelvis, rupture of membranous urethra. Perineovesical fistula, calculi in urethra and bladder. Calculi removed through vesical and perineal incisions. Subsequently operation to excise vesicoperineal fistula and repair internal and external sphincters to cure incontinence; successful. B. U. I. 9234.

Another form of inguinal urinary fistula is that in which there is an escape of urine through the vas deferens. We have had one such case following epididymectomy in which the vas had been divided at the external ring. A urinary fistula formed in the groin and investigation showed that the urine came out through the vas deferens, evidently having passed from the posterior urethra through the ejaculatory duct. In such a case the canal of the vas may be obliterated by injection of pure carbolic.

Perineal Fistula.—Here again the fistulæ vary greatly in their etiology and

character. They may result from traumatism, prevesical, periprostatic or prostatic abscess, tuberculosis, urethral and prostatic calculi, etc. In most cases the fistula leads to the anterior or lateral walls of the bladder, the fistulous tract extending beneath the pubic arch. The urine usually escapes continuously. In

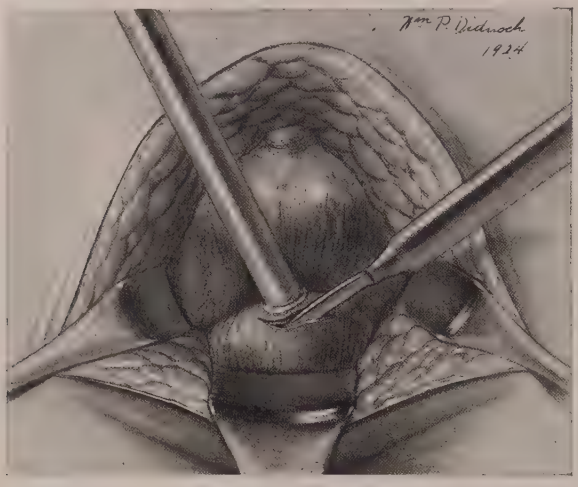


FIG. 752.—Perineovesical fistula (in base of bladder) drawn down by prostatic tractor, incision circumscribing the vesical opening behind the prostate begun.

other cases the perineovesical fistula may pass behind or to one side of the prostate and under the floor of the bladder.

Operative attack depends greatly on the course of the fistula. Where the opening is anterior to the triangular ligament, one must use great care in dissecting out

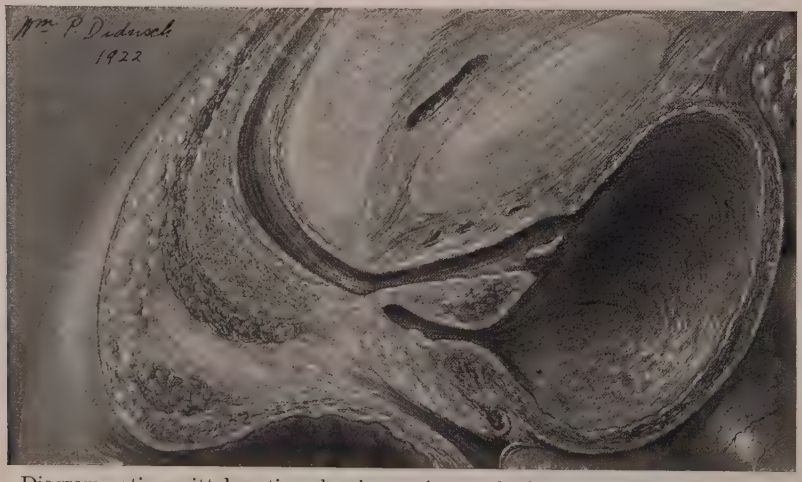


FIG. 753.—Diagrammatic sagittal section showing vesico-urethral fistula, obliteration of membranous urethra from fracture of pelvis. Urinary incontinence. B. U. I. 10,365.

the fistula to avoid injury to the external sphincter. As a rule, a suprapubic incision is necessary in such cases and the upper half of the tract had best be attacked by prevesical dissection of the fistulous tract and complete closure of the bladder wound with prevesical and urethral drainage. In some of these cases one finds a

stricture of the urethra or contracture of the prostatic orifice. These should be radically treated. In other cases calculi are found obstructing the urethra and responsible for the para-urethral fistula (Fig. 751). Such stones are removed and

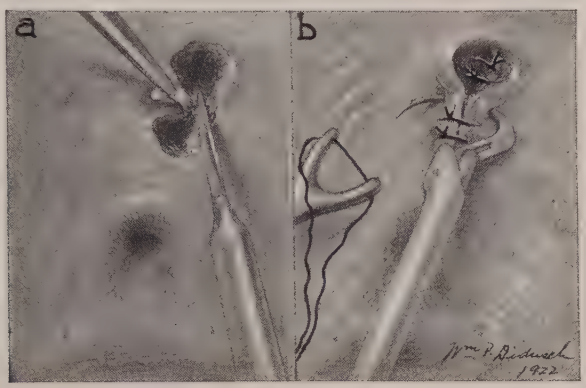


FIG. 754.—Excision of vesical fistulæ, closure with two layers of catgut sutures. The obliterated urethra was restored by forcing a small sound through until it appeared at the true orifice, controlling its course by palpation and inspection, *a*, Mucosa removed from fistula; *b*, fistula closed with boomerang needle-holder. B. U. I. 10,365.

bladder drainage through the urethral wound instituted, so as to facilitate closure of the para-urethral fistula.

Where the perineovesical fistula emerges from the bladder posterior to the prostate it does not penetrate the triangular ligament, but opens upon the skin behind

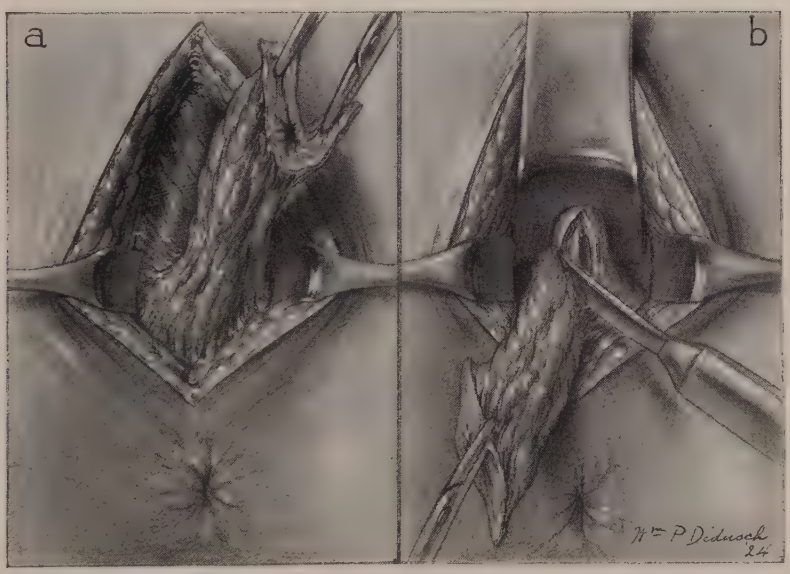


FIG. 755.—Showing, *a*, excision of extensive scar tissue leading to point of rupture of urethra in case of incontinence. *b*, Considerable portion of the dilated urethra was excised with the scar tissue. B. U. I. 10,365.

it. It may be excised through a typical perineal prostatectomy incision. In such cases we have employed with excellent result, our long urethral tractor, by means of which the retroprostatic space was exposed and the fistulous tract followed to its opening into the bladder. In order to excise thoroughly the vesical margins of the

fistula, another tractor (short) was introduced through the fistulous opening into the bladder, which was then drawn down, the vesical end of the fistula excised (Fig. 752) and sutures placed before removing the tractor. In such cases, suprapubic operation has not been necessary.

Vesicoperineal urinary fistula in the presence of tuberculosis of the bladder, prostate, or seminal vesicles should be treated if treated at all, by incision and drainage, and no attempt made to excise or close until the tuberculous process has been eradicated. The same rules apply to fistulæ associated with prevesical or

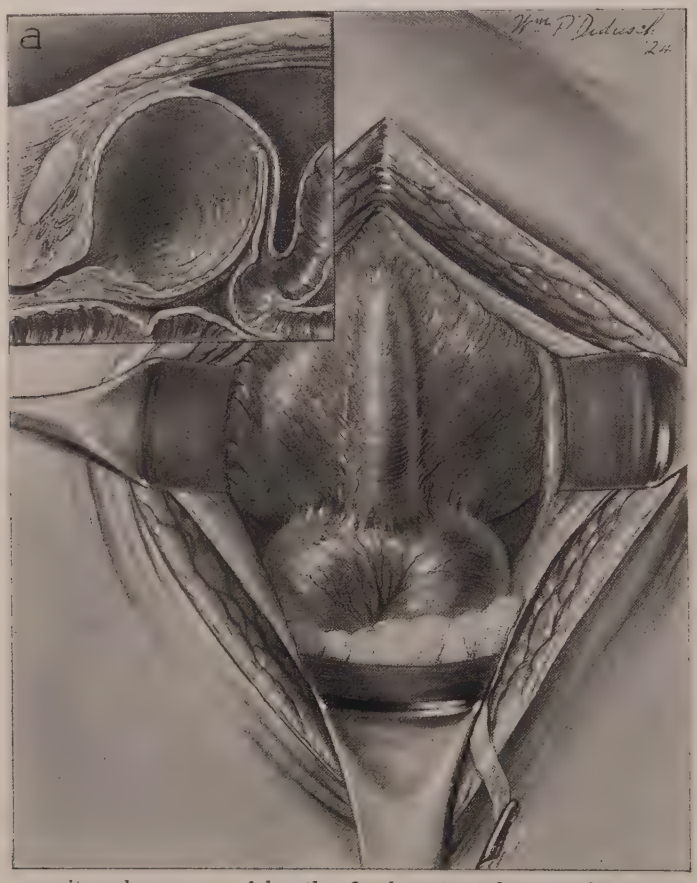


Fig. 756.—Transperitoneal exposure of lengthy fistulous tract between intestine and bladder: *a*, Sagittal section showing same. B. U. I. 10,901.

periprostatic infections and also to pilonidal sinuses, which must be cured by excision before the fistula can be expected to heal.

Vesico-urethral Fistula.—Traumatic false passages reaching the bladder may persist as vesico-urethral fistulæ, giving incontinence, dysuria, and other symptoms. After careful diagnosis—which may be very difficult—one plans the operative procedure to excise the fistula, close the bladder, and restore the normal urethra. If there is stricture or occlusion, the last is essential to success. Such a case, successfully treated in our clinic by Colston, is shown in Figs. 753 to 755.

Vesico-intestinal Fistulæ.—Here again great variation occurs as to the location and character. They may follow abscesses—cecal, appendiceal, pelvic, etc.—

tuberculosis or cancer of almost any portion of the intestinal tract, intestinal diverticula, traumatisms, etc. The operative treatment depends upon the underlying cause and the character of the fistula. Where the fistula is simply due to inflammatory adhesions between a portion of the intestine and the bladder and communication between the interior of the two cavities, it can usually best be attacked by means of abdominal operation. The appearance is often such as is seen in Fig. 756, and the operation consists in dividing the adhesions, excising the fistulous tract, and closing the two openings separately (Figs. 757, 758). The bladder is

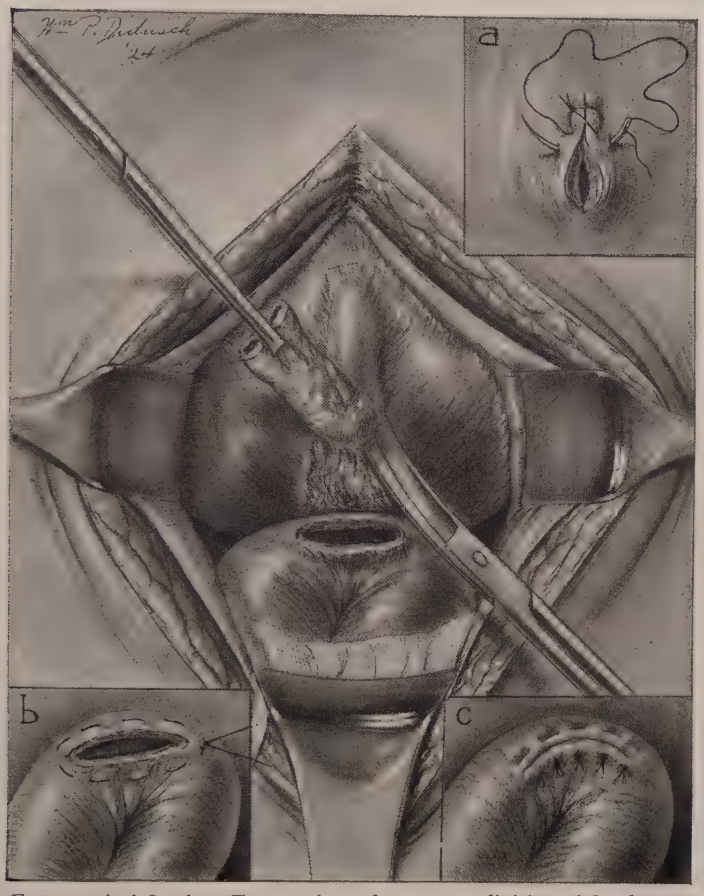


FIG. 757.—Enterovesical fistula. Transperitoneal exposure, division of fistula at connection with intestine, fistulous tract is being excised from posterior wall of the bladder: *a*, Intraperitoneal closure of bladder. *b*, Closure of intestinal opening with purse-string. *c*, Second layer of sutures (mattress). B. U. I. 10,901.

drained with a de Pezzer catheter, and the abdomen is closed with or without drainage (depending on how satisfactory the vesical closure was).

When the fistulous connection is between the *bladder and the rectum* it is extremely difficult to reach it by the abdominal route. In one such case, however, after separating the bladder from the rectum, we closed the vesical opening from behind the bladder and the rectal opening through the abdomen retrovesically, as shown in Figs. 759, 760. In other cases we have attacked vesicorectal fistulæ through the perineum with the aid of our long prostatic tractor in the urethra.

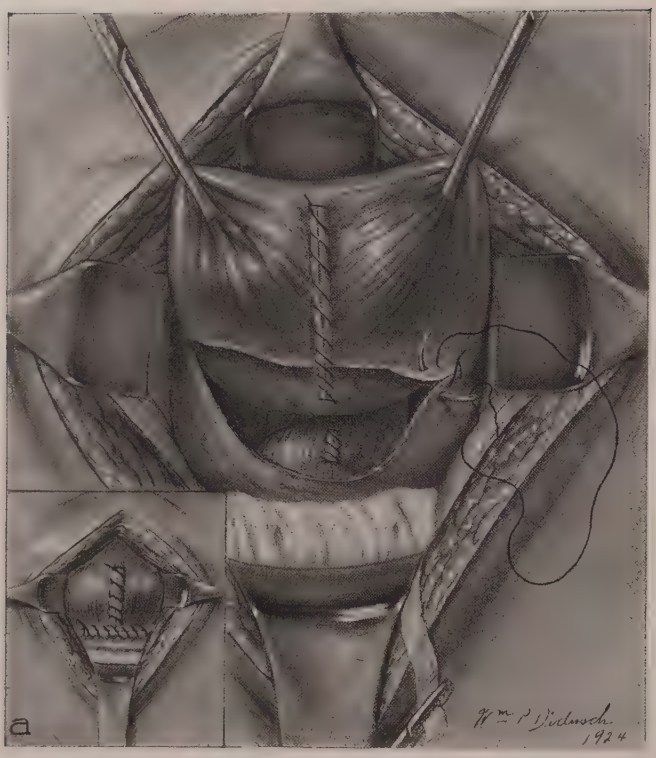


FIG. 758.—Enterovesical fistula. Closure of bladder and intestinal wounds completed. Closure of posterior opening in peritoneum begun. B. U. I. 10,901.

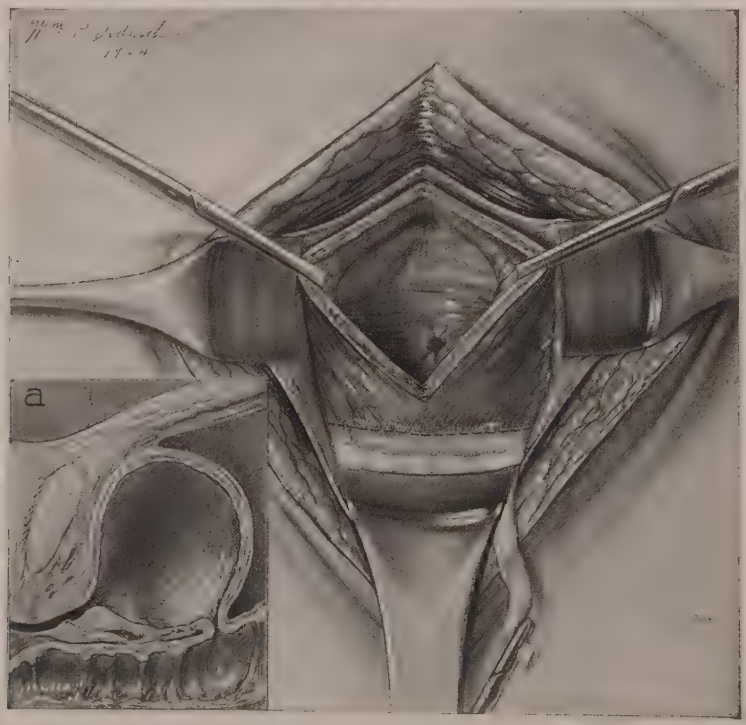


FIG. 759.—Transperitoneal and intravesical resection of rectovesical fistula. Bladder opened, exposing fistula back of trigone. Dotted line shows location of incision through peritoneum at bottom of Douglas' pouch. *a*, Longitudinal section showing location of fistula. B. U. I. 6763.

The incision is that of the radical operation for tuberculosis of the seminal vesicles. The posterior surface of the bladder may thus be exposed and the fistulous tract divided. The two openings are then closed separately with continuous sutures, a cigarette drain inserted between the two viscera, urethral drainage supplied, and the perineal wound partly closed. In the operation upon the vesical opening a tractor inserted into the bladder may be of considerable assistance.

Enterovesical fistulæ due to malignant disease or tuberculosis of either intestine or bladder require a much more extensive operation, according to the size of the tumor and the extent of involvement. Where the tumor was vesical in origin extensive resection of the bladder is required and possibly also of the intestine. In

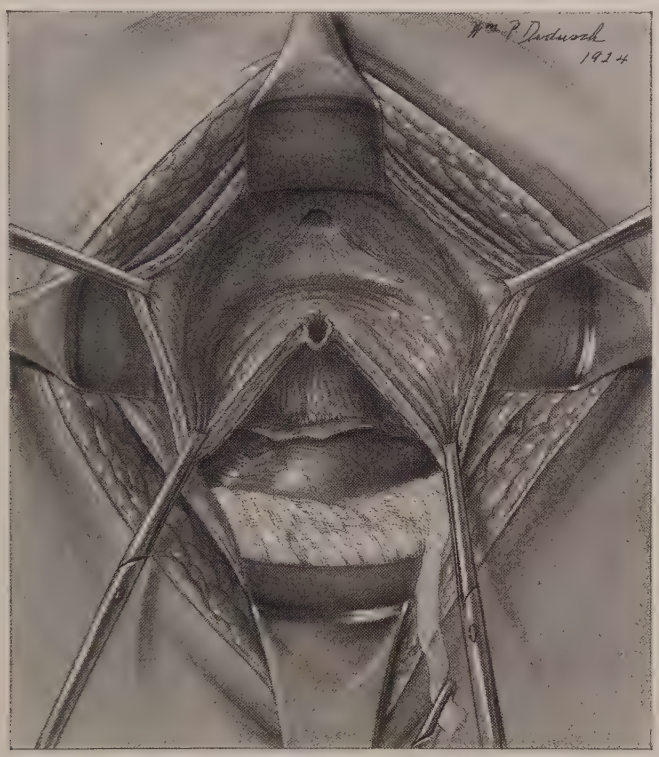


Fig. 760.—Intraperitoneal transvesical resection of rectovesical fistula. Peritoneum divided transversely at bottom of Douglas' pouch, exposing rectum and upper wall of fistulous tract. B. U. I. 6763.

one of our cases we found a carcinoma involving the ileocecal and appendiceal region, which had become adherent to the bladder with a resultant enterovesical fistula (Fig. 761). In this case a small resection of the bladder, and very extensive resection of the intestine (cecum, appendix, and ileum) was required.

Vesicovaginal, Vesico-uterine Fistulæ.—These belong largely to the domain of gynecology and have not come within the sphere of our clinical experience. The subject is so vast that its adequate treatment would require many pages excerpted from the literature. The reader is, therefore, referred to the standard text-books of gynecology and also to lengthy chapters on the subject in Kelly-Burnam (Diseases of the Kidney, Ureter, and Bladder, vol. ii, 407) and to Albarran (Médecine Opératoire des Voies Urinaires, p. 680). In brief, it may be stated that the

fistulous tract should be exposed, the bladder and vagina separated and all fibrous tissue carefully excised so as to obtain healthy muscle for a good closure of both vesical and vaginal openings. The method of attack varies very greatly, some preferring to go through the vagina, others through the bladder, and still other surgeons employing both routes simultaneously. The technic of closure and the suture material also vary greatly. The first successful operations of Sims were with silver wire, which is still employed by many (Fig. 762). Another method is

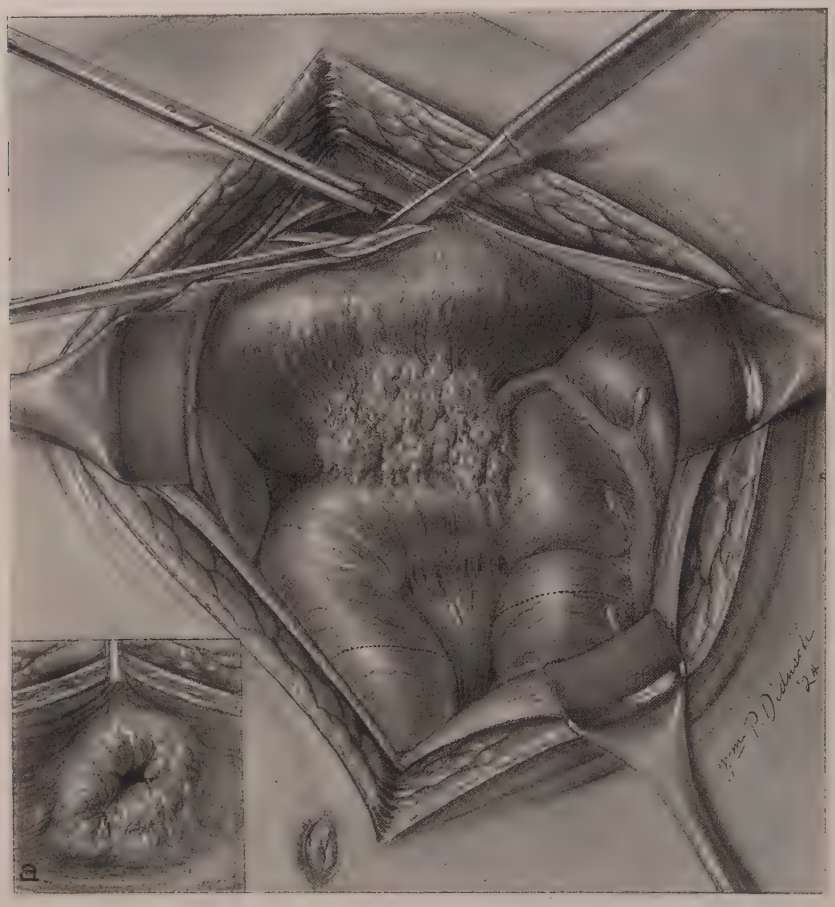


Fig. 761.—Carcinoma of appendix involving bladder and sigmoid. Enterovesical fistula. Intraperitoneal exposure, bladder opened. *a*, Vesical orifice of fistula. B. U. I. 8398.

shown in Fig. 763. Perhaps we may be pardoned if we quote as follows from Thompson Walker:

The ureters should be properly safeguarded by passing a catheter along each at the commencement of the operation.

There are three methods of approach: (1) Vaginal; (2) vesical; (3) peritoneal. The *vaginal method* is that which is most frequently employed. The author makes use of Young's prostatic tractor, introduced from the vagina through the fistula, in order to pull down and steady the fistula during the operation, and dissects up large anterior and posterior flaps of the vaginal wall, which are brought together after excision of the tract.

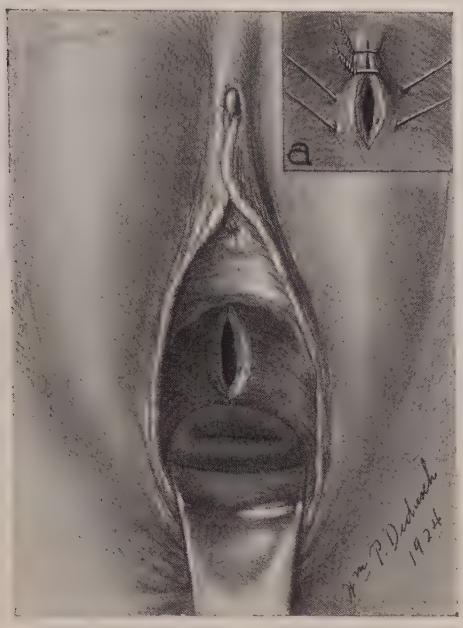


FIG. 762.—Vesicovaginal fistula, edges of fistula excised. *a*, Approximation of edges with silver wire sutures.

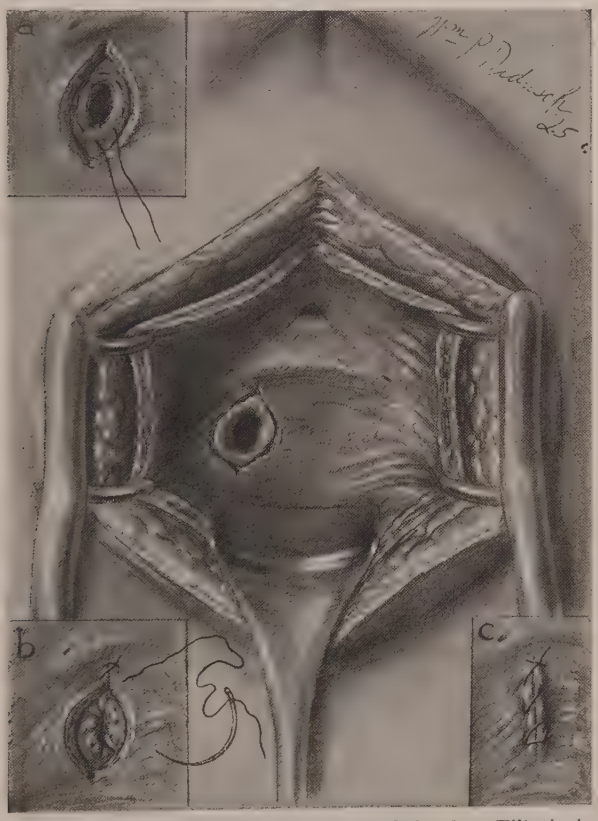


FIG. 763.—Suprapubic operation to close vesicovaginal fistula. Elliptic incision around orifice through vesical mucosa. Eversion of fistulous tract. Closure with purse-string chromic catgut suture placed through the bladder (*a*, *b*). Closure of bladder wound with continuous plain catgut (*c*).

OPERATIONS FOR EXSTROPHY OF THE BLADDER

As described elsewhere, the condition presented is an absence of the anterior vesical wall, extroversion of the open bladder, ureteral orifices, trigone and urethra, absence of vesical and urethral sphincters, epispadias, corpora cavernosa in apposition beneath the urethral gutter, imperforate glans, wide separation of pubic bones, absence of symphysis pubis, incontinence of urine and continuous wetting of clothes. The problems that are presented to the surgeon are distinctly shown in Mr. Didusch's drawings of a recent case (Figs. 544, 545).

The operations which have been formulated for the attack upon exstrophy of the bladder have thus been summarized by Thompson Walker:

I. Formation of a reservoir in the body.
  A. From the bladder.
    1. Closure of the defect by osteoplastic operations.
    2. Closure of defect by flaps.
      (*a*) Autoplastic methods.
        (i) Of skin.
        (ii) Of intestine.
      (*b*) Heteroplastic methods.
  B. From the rectum.
    1. By transplantation of the ureters.
    2. By vesicorectal fistula.
  C. From the sigmoid flexure.
  D. From the vagina.

II. No reservoir formed in the body.
  1. Implantation of the ureters.
    (*a*) In urethra.
    (*b*) In skin.
  2. Nephrostomy.

Operative Treatment of Exstrophy of the Bladder.—In 1851 Simon transplanted the ureter into the rectum and was apparently the first to attempt to divert the urine into the intestinal tract. The operation was unsuccessful.

Roux, in 1852, did a plastic operation to construct a bladder of the abdominal wall and a modification of this was attempted by Nélaton in 1854, but both were unsuccessful.

The first successful plastic operations, according to Hutchins, were by Ayres and Pancoast, Americans, who in 1859 reported cases. Wood in 1869 reported 8 cases. No attempt was made by these surgeons to control the urine which was caught by means of an apparatus.

In 1885 Trendelenburg proposed the following technic: Sacro-iliac arthrotomy, on one or both sides, was done, and the child placed in an apparatus which was intended to approximate the separated pubes. It was necessary for the patient to remain in this for three or four months. The second stage of the operation consisted of a reduction and suture of the bladder and closure of the anterior abdominal wall.

Wilms added a special compressor by means of which the bones were brought together, without injury of the soft parts. As a result of this method Trendelenburg[1] claimed success in 3 cases with some control, which was prolonged during the night. Katz, quoted by Thompson Walker, collected 23 cases with a mortality of 22 per cent.

[1] Treatment of Ectopia Vesicæ, Annals of Surgery, 1906, xliv, 281.

Recently Dünkeloh[1] summarized the first 7 cases operated on by Trendelenburg according to his method of mobilizing the bones and re-uniting the walls to make a bladder cavity, and gave 11 other cases in which this method was applied by others. To this list he added 8 unpublished cases from Trendelenburg's records. Complete continence was not realized in any instance and only in 1 case for an hour's duration. A simple spring contrivance worn on the penis is now used and insures continence at will. Pyelonephritis developed later in only 1 case.

Legueu says that this operation not only does not give control, but is more fatal than the others, and has not justified the hopes upon which it was based.

From a review of the literature, Hutchins[2] declares that the only way to eliminate incontinence is by transplanting the ureters into the intestine either intraperitoneally or extraperitoneally. In this excellent report the literature is fully covered.

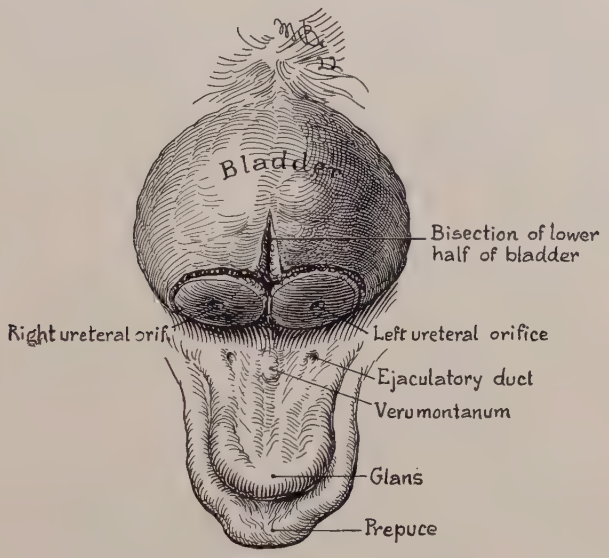


Fig. 764.—Operation for exstrophy of bladder, incisions preparatory to transplantation of ureters.

Maydl was the first surgeon to transplant successfully the trigone with ureters intact, intraperitoneally. According to Buchanan, the immediate mortality in Maydl's operation is 28.7 per cent. Of 57 patients who recovered, 65 per cent. have lived one year, 24 per cent. over five years. To this number, if we add Steven's list of 16 cases, the immediate mortality becomes 28.1 per cent.

Bergenhem's operation consists of an independent extraperitoneal transplantation of the ureters into the rectum with a rosette of bladder wall and removal of the bladder. Figures show a mortality of 11.5 per cent. Of 28 patients who recovered from the operation 60.7 per cent. have lived over one year and 21.4 per cent. over five years. According to Hutchins, the Mayo Clinic has probably a larger number of cases of exstrophy than any other clinic. Their method of operation is as follows: The ureter is divided about 1 inch from the bladder wall, the

[1] Deutsche Zeitschrift für Chirurgie, 1914, cxxix, 71–104.

[2] Hutchins, E. H., and Hutchins, A. F.: Surgery, Gynecology, and Obstetrics, 1923, xxxvi, 731–741.

lower end is ligated, and the peritoneum closed. At a point opposite the isolated ureter, an incision is made through the outer coats of the bowel, and at the lower

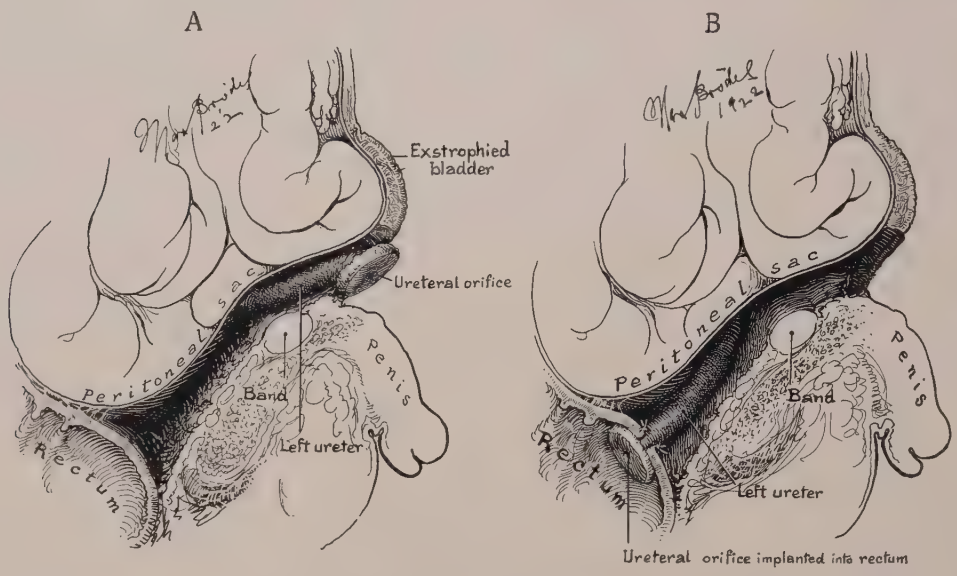


FIG. 765.—Operation for exstrophy of bladder. A, Freeing of left ureter and preparation of space in front of peritoneum preparatory to transplantation of ureters into rectum, B.

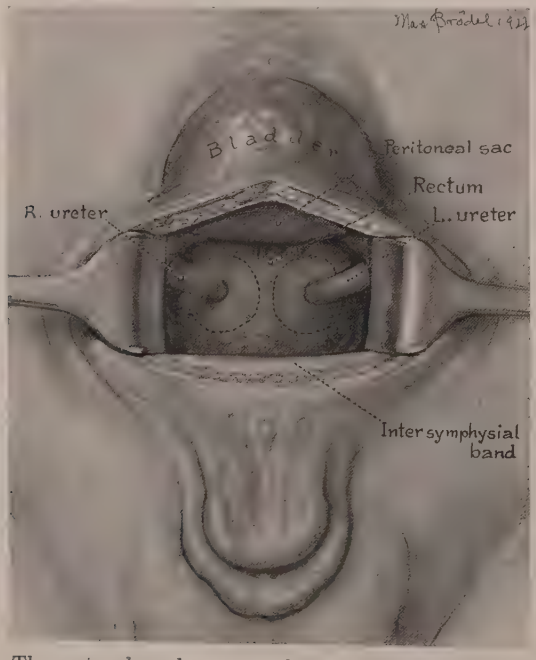


FIG. 766.—The ureters have been transplanted extraperitoneally into rectum.

end a puncture is made through the mucosa, large enough to admit the ureter. The ureter is drawn through and fixed. The divided peritoneum and muscle of the intestine are then approximated over the ureter. One ureter is transplanted

at the first stage and in about ten days the second ureter is transplanted. In the third stage the bladder is enucleated and the short ureteral ends, attached to it, removed. In their series of 52 patients, 6 were operated on by the plastic method. Of these, 1 died six months later. Three were operated on by the Maydl-Moynihan method, 2 of whom died of uremia. Twenty-six were operated on by the transplantation method, 22 successfully.

One of the most interesting recent contributions to this subject has been made by Dr. A. F. Hutchins of our staff and his brother, Dr. E. H. Hutchins.[1] The ac-

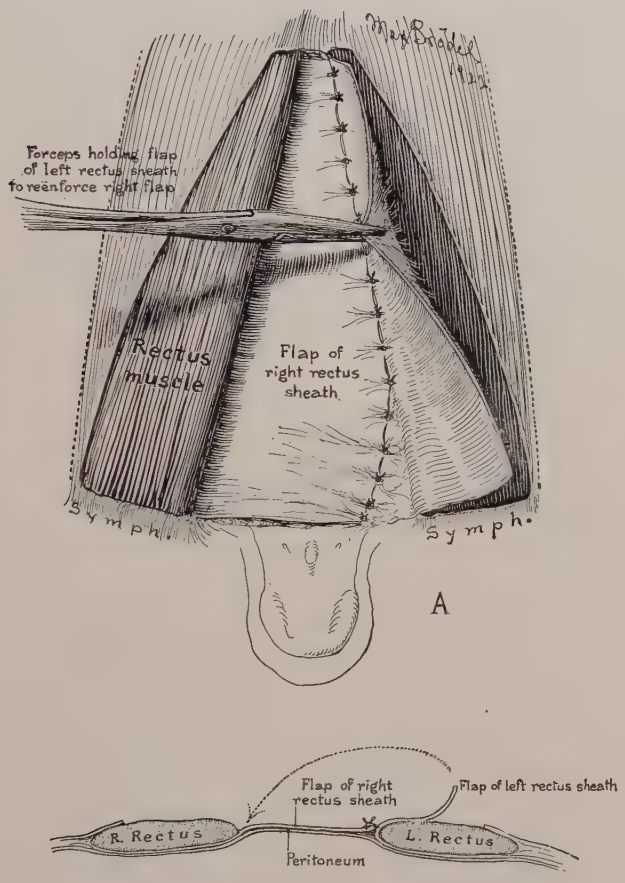


Fig. 767.—Operation for exstrophy of bladder. A, Closure of abdominal wall after transplantation of ureters and excision of bladder. Anterior sheath of recti used to cover triangular defect and cure hernia. B, Diagrammatic transverse section.

companying illustrations (Figs. 764–767), which are taken from their paper, show very graphically the technic which they have employed in 2 interesting cases which they report.

The first patient, a boy aged five, was followed seventeen months and had an excellent result; was able to retain urine in the rectum for several hours and had

[1] Exstrophy of the Bladder, Surgery, Gynecology, and Obstetrics, 1923, xxxvi, 731–741.

good rectal control. The boy died of influenza during the epidemic of October, 1918—seventeen months after operation. No postmortem was obtained.

The second patient was a man aged twenty who was operated upon three years ago. We have seen this patient, who is in excellent health and is able to retain urine for four hours by rectum. He has no intestinal disturbances and good rectal control. The abdominal wall is well closed. There is no hernia present, the epispadias has been cured by a skin transplant. He has normal erections and ejaculations, and has had intercourse several times and states that the act is quite normal and satisfactory. The details are so thoroughly exposed by the illustrations that no further operative description seems necessary.

In discussing the operation the authors say as follows:

> When we consider these two methods and compare them, we find a much higher primary mortality following the Maydl operation. Naturally any method which necessitates opening the peritoneal cavity must tend toward a high mortality, mainly on account of the greater chances for infection, and the greater risk from shock. The extraperitoneal operation, therefore, in our opinion, is the easiest and the safest method of transplanting the ureters in exstrophy of the bladder. With any method transplantation of the ureters, if it be carefully and properly done, is of necessity a very delicate piece of work, and the dissection must be made in such a way as to cause a minimal amount of trauma, so that the nerve and blood-supply to the parts may not be destroyed or materially injured. When the Bergenhein method is employed the rectum should be carefully cleansed before operation. The ureters should be dissected out far enough so that, when transplanted, they will not be subjected to any tension. Kinks and twists should be carefully avoided.

Many ingenious schemes have been devised with the hope of producing a pouch or cul-de-sac of some portion of the intestinal tract into which can be transplanted the ureters or trigone which convey the urine. None of these procedures seem to have any marked advantage over the simple transplantation of the ureters into the rectum. As the operations require much more intestinal manipulation and are accompanied by a higher mortality they are not recommended.

Soubbotine proposed the following procedure, the hope of which was to obtain urinary control through an extrarectal passageway. The steps were as follows:

> With patient on his face, after resection of the coccyx, the posterior wall of the rectum is exposed and opened by a longitudinal incision, which includes the external sphincter. A fistula is formed between the posterior wall of the bladder and the rectum. An incision is made in the shape of a U, starting from the anal orifice and running upward around the fistula and out to the anal orifice again. From this strip of rectal wall a tube is formed which leads from the vesico-rectal fistula outward to the anal orifice. This produces another tube within the anal sphincter, but outside of the rectum when this is drawn together over the tube of rectal mucosa. The anal sphincter is then closed posteriorly and the rectal wall and skin are also approximated. As a result, the anal sphincter contains the now contracted anus and the newly formed tube which is intended to convey the urine from the bladder out through the anal sphincter externally.

The object of the operation, of course, is to have the anal sphincter act as a cut-off mechanism to restrain the outflow of urine from the bladder, which has been closed suprapubically. At last report 9 patients had been operated upon, 3 of whom had died from septicemia. In some of the cases the results were not satisfactory. One patient followed two years may be said to have a good result with micturition five or six times a day and vesico-urethral capacity of 100 c.c. In some of the cases the condition was one of penopubic epispadias (such as we re-

port elsewhere) and not of exstrophy. Legueu considers that the operation has not been proved a success.

Operation to Restore Urinary Control and Cure Exstrophy of Bladder.—Following the success which we had obtained in the cure of incontinence of urine in cases in which the internal and external sphincters had been injured and were dilated, it occurred to us that the same plastic method could be utilized to restore the vesical neck and urinary control in cases of epispadias with incontinence. Elsewhere (Chapter XX) we have detailed the remarkable success which has been obtained in cases of epispadias with incontinence by means of a suprapubic attack

Fig. 768.—Boy of six years with epispadias, incontinence of urine, and partially cured exstrophy of bladder. Widely separated pubic bones and recti muscles. *a*, Penis drawn down with hooded foreskin, showing wide open vesical neck. B. U. I. 9534.

upon the internal sphincter and a plastic to restore the internal and external sphincters. As a result of these cases we determined to try a similar procedure in cases of exstrophy of the bladder with incontinence. As such cases are always associated with epispadias, a good part of the operation would necessarily be quite similar in technic to the methods which we had already employed.

The following case is that of a boy who had also been subjected to 5 previous operations to cure the exstrophy, with considerable success, but who still had incontinence of urine and complete epispadias. The accompanying illustrations (Figs. 768–774) depict the technic which was employed so thoroughly that very little description is necessary.

B. U. I. 9534, G. D., boy, aged five, admitted October 5, 1923. Normal labor at term. Weight of baby, 5½ pounds. Examination showed complete exstrophy of the bladder. Dr. Polak of Brooklyn replaced the bladder within the abdominal cavity and brought the abdominal walls over it as much as possible. Three months later abdominal wall was brought into nearer approximation over the bladder. When child was ten months of age a second operation was performed and at sixteen months a third operation was done by Dr. Polak. It was hoped by these operations to cure the exstrophy. The epispadias continued and urine flowed out freely from the neck of the bladder in the suprapubic region. March 22, 1923, examination: Patient has had 5 operations for inversion of the bladder, finally with good result. At present the bladder is completely covered. There is a fistulous opening into the bladder, 1 cm. in diameter, at base of penis. Penis lies above the symphysis, being markedly curved upward and deformed (Fig. 768),

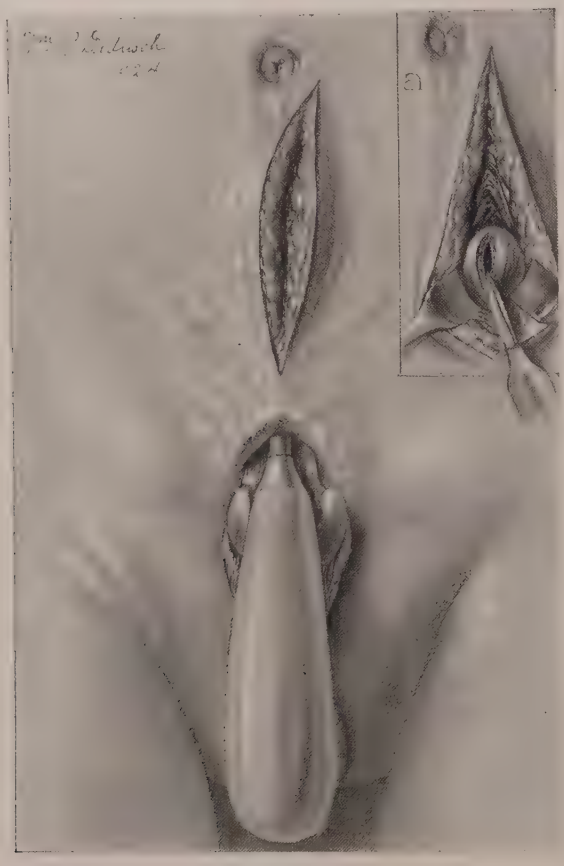


Fig. 769.—Median line incision, instrument in bladder. *a*, Incision of bladder wall upon instrument. B. U. I. 9534.

with complete epispadias. The glans is divided and the floor of the urethra is an open trough (Fig. 768, *a*). The corpora cavernosa are approximated beneath the urethra. The scrotum is flabby and testes absent. The bones of the symphysis are widely separated. The urine escapes continually.

October 12th, plastic operation to repair epispadias and cure incontinence of urine; suprapubic cystotomy; exposure of entire bladder, as shown in Figs. 769, 770. Discovery of a wide open vesical neck with no functioning internal or external sphincter. Excision of redundant prostatic urethra anteriorly (Fig. 771). Linear incisions along dorsum of penis with dissection of mucous membrane to form a new urethra, according to Young technic, leaving the skin attached to the left corpus cavernosum, which was separated in the median line from the right corpus (see Chapter XX, Epispadias). Formation of new urethra (Fig. 772) with continuous chromi-

cized catgut stitch which began at vesical neck and drew muscles tightly together around a very small catheter, thus restoring the internal sphincter and external sphincter, and producing a tight prostatic urethra and the complete anterior urethra (Fig. 772, *a*). New urethra buried beneath the corpora cavernosa which were drawn together above it with two layers of chromicized catgut (Fig. 773). The glans had been divided so as to place urethra in proper position ventrally. Musculature in region of prostate and vesical neck drawn together in three layers with chromicized catgut. The last layer was continued backward so as to close the bladder up to vertex where drainage with a mushroom catheter was provided (Fig. 774). Glans approximated with interrupted sutures of fine silk, skin on dorsum of penis approximated with silk. Pubic bones pushed together by hand and sutured close together by means of heavy silver wires which included periosteum and deep fascia on each side. Fairly good approximation obtained. This

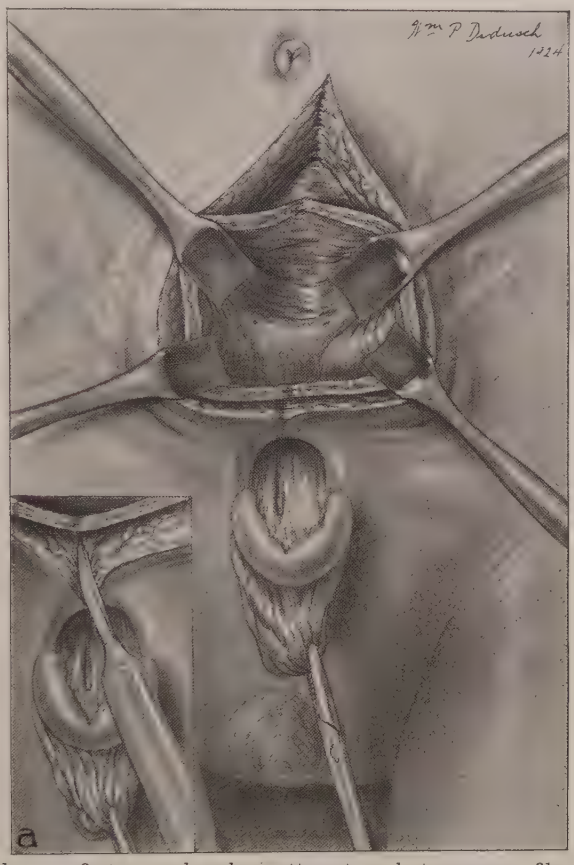


FIG. 770.—The bladder was first opened and an attempt made to preserve fibrous bridge connecting the two pubic bones. It was found necessary to divide this (*a*). B. U. I. 9534.

was reinforced by a deep catgut stitch and also silver wire, which included skin and deep structures at base of penis. Recti muscles drawn together with interrupted stitches of silver wire, good approximation obtained. Skin clips between (Fig. 774).

Convalescence.—Shortly after operation the child pulled out the urethral catheter. Suprapubic drainage was maintained. A few days later an attempt was made to pass small instruments through the newly formed urethra into the bladder, but obstruction was met with at the vesical orifice. Continuing these attempts a probe was finally passed into the bladder, but subsequent examinations showed that this had penetrated the roof of the urethra and did not pass through the newly made prostatic portion of the urethra, the internal orifice of which had closed completely. The patient was discharged with two urinary fistulæ, one at the vertex and one at the base of the penis. The result of the epispadias operation was good, a well-formed penis with urethra beneath the corpora.

Patient subsequently returned on June 13, 1924, when a second operation was done in an attempt to close the fistulæ and open the closed prostatic orifice. The plastic at vesical neck was quite similar to the first operation, but without success, in that when patient was discharged he still had a suprapubic fistula, a small opening at base of penis and urine did not flow through the urethra.

January 6, 1925, third admission. Patient returns with two suprapubic fistulæ. Urine escapes through penis, but without control. On examination a pouch is found in the prostatic urethra and the smallest instrument refuses to pass into the bladder. On the anterior wall of the urethra about the membranous portion is an opening which passes into the bladder, thus short-circuiting the prostatic urethra.

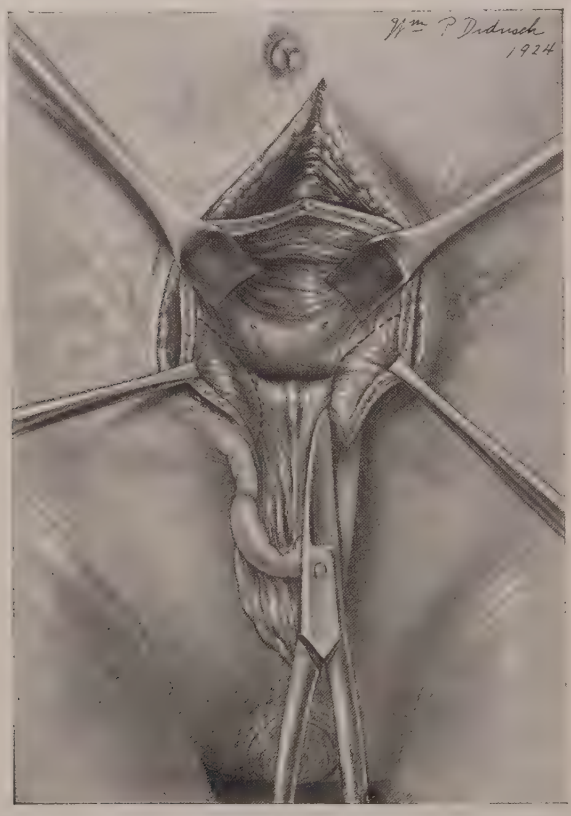


Fig. 771.—The base of bladder and urethra are exposed. The redundant portion of the dilated posterior urethra and adjacent bladder wall are being excised to the left of the verumontanum and vesical neck preparatory to placing sutures to provide a continent internal sphincter. B. U. I. 9534.

January 16, 1925, bladder opened widely. Inspection of vesical neck shows that the prostatic orifice is tightly closed with a pouch in front, in which the end of a probe passed through the penis can be felt. About 1 cm. in front of this is an opening along the roof of the membranous urethra which communicates with the bladder. A grooved director is passed through the penis and prostatic urethra and forced through the septum into the bladder. Palpation shows quite a mass of muscle surrounding this instrument, and sufficient, it is believed, to constitute an internal sphincter. The newly made internal orifice was then dilated and a catheter passed retrograde from the bladder out through the urethra by means of a suture tied to a probe in the urethra. The orifice in the roof of the urethra (membranous portion) was then excised and closed with deep sutures of silver which were brought out through the skin. The bladder wall was then approximated by catgut (two layers) with no exit for drainage. The recti muscles, fascia, and skin were then drawn together with two widely placed silver wire sutures, with clips for intervening skin. The suprapubic fistula then closed, and the patient voided naturally through the urethra. The bladder

gradually dilated until it held 100 c.c. of urine, with good control. September 28, 1925, letter: Patient is able to retain 125 c.c. without leakage when lying down. He voids with considerable force. When playing there is apt to be leakage. "We are faithfully drilling him to exercise his sphincter muscles." Comment: Result evidently as yet not perfect.

Résumé as to the Cure of Incontinence.—Reviewing briefly the 3 cases of epispadias with incontinence, and the 2 cases of exstrophy and epispadias with incontinence, we find that in 4 of the 5 cases urinary control has been obtained by means of the plastic operation which we first proposed in 1920.[1] The essential

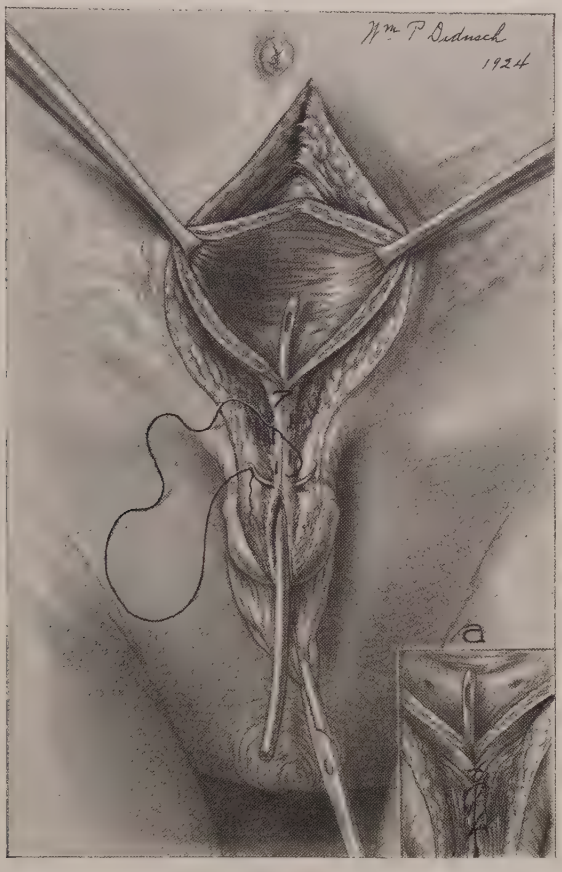


Fig. 772.—Young's radical operation to cure exstrophy of bladder, incontinence of urine, and epispadias. First layer of sutures is being placed to form a tight vesical neck and new urethra. Pendulous portion left attached to left corpus cavernosum, as described in text. B. U. I. 9534.

part of this operation is simply to resect the anterior and lateral walls of the dilated prostatic and membranous urethra until muscle is obtained and the mucous membrane sufficiently resected to form a good tight posterior urethra. Dilatation is necessary subsequently to prevent contracture and stricture formation. The cure of epispadias by means of our rotating plastic operation has also been entirely successful. We have not yet had experience in very severe cases of exstrophy and difficulty may be experienced in some of these cases in completely closing the bladder, but in the 2 cases operated upon we have succeeded in approximating the

[1] Young: Journal of Urology, 1922, vii, 1–32.

lateral surfaces of the bladder after completely freeing the bladder on all sides. We believe that this can probably be carried out in all cases, even when the exstrophy is very considerable. We have not found it necessary to carry out arthrotomy at the sacro-iliac joints nor to divide the rami of the pubes.

The method employed by Hutchins to cover the abdominal defect has been very successful in his cases. In our cases in which there was marked separation we were able to draw the recti muscles together and get good union with no ventral hernia subsequently.

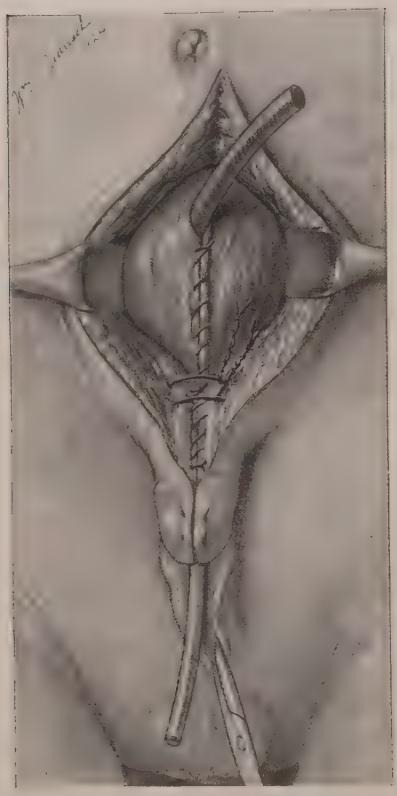


Fig. 773.—Final closure of bladder urethra. Approximation of pubic bones over prostatic urethra. Corpora approximated over the rotated new urethra which is brought out on under surface of reconstructed penis. B. U. I. 9534.

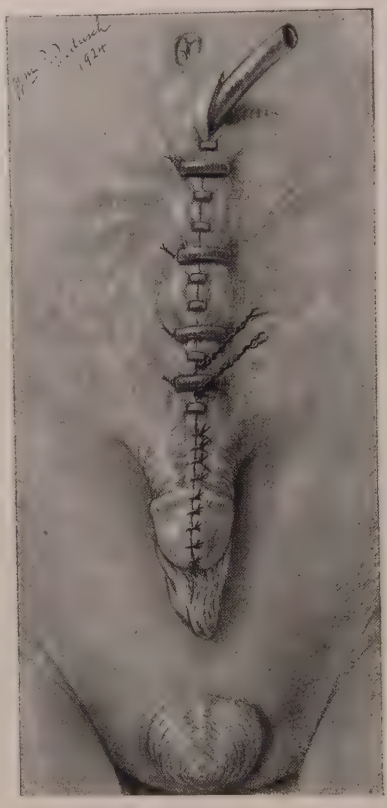


Fig. 774.—Final closure with suprapubic drainage of bladder at upper end. Silver wire sutures (two) to approximate symphysis pubis in front of newly made urethra which has been transferred to under surface of penis. B. U. I. 9534.

It may in time prove desirable to make use of a plan recently suggested by Burns,[1] which is as follows:

With patient in the perineal prostatectomy position, an inverted U incision is made. The fossæ on either side are explored and central tendon divided as in Young's perineal prostatectomy. The levator muscles are exposed and separated and the base of the bladder can then be readily seen. With one finger in the bladder pouch from above, and another in the perineal wound, the peritoneum is dissected free from the posterior wall of the bladder and from the anterior wall of the rectum and the peritoneal reflection pushed forward. Three sutures are then placed in the base of the bladder, one on each side of the outer side of the trigone, and the third

[1] A New Operation for Exstrophy of the Bladder, Journal of the American Medical Association, 1924, lxxxii, 1587–1590.

in the midline, posterior to the trigone. The lateral sutures are brought through the fascia of the pelvic floor and the median through the central tendon of the perineum. These are left untied and attention then directed to freeing the bladder from above by blunt dissection as far as the rim which is attached to the abdominal wall. As the bladder has been freed everywhere except at its base, the three perineal sutures are tied, drawing the bladder well down into the pelvis. The bladder wall is then closed by continuous sutures in two layers, etc.

This procedure of Burns can easily be combined with the plastic operation which we have carried out with the object, not only of depressing the bladder and thus producing a larger vesical pouch, approximating the bladder anteriorly and thus curing the exstrophy, but also obtaining a continent bladder by the plastic upon the prostatic and membranous urethra as described above, the epispadias being cured at the same time by continuation downward of the sutures. In Burns' case the patient was placed in a plaster cast for four months, but these measures only procured a narrowing of the defect at the symphysis by 1.5 cm. In our cases just as satisfactory results were obtained by simple wire sutures and a tight belt. As a matter of fact, complete approximation is apparently never obtained and is not necessary for an optimum result.

Conclusion.—While our cases are still too few to draw any sweeping conclusions, we believe we have demonstrated that it is possible to obtain urinary control in both epispadias and exstrophy of the bladder, and that the future will see a conquest of this most terrible of all urinary afflictions—the exstrophied bladder.

OPERATIONS FOR PERIVESICAL INFECTIONS

The operations which may be required for infection and abscess around the bladder depend considerably upon the initial lesion responsible for the condition. Many of these infections follow endovesical diseases which may require simultaneous treatment. Others will depend upon infections of prostate and seminal vesicles, which have spread to the tissues around the bladder. Still other cases are due to disease in other organs, *e. g.*, pyosalpinx, appendicitis, diverticulitis, colitis, pelvic abscess, and malignant disease of the pelvis or intestines which has invaded or become adherent to the perivesical tissues leading to suppuration in this region. The operative treatment depends on the cause and position of the infection and may be divided as follows:

Abscesses and Simple Infections of the Space of Retzius.—These are generally reached easily by a suprapubic extraperitoneal prevesical operation. Abscesses in this region may be opened and drained satisfactorily through a simple median incision unless they extend widely on one side or both sides, in which case it may be desirable to make lateral incisions for the insertion of drainage-tubes. In so doing it is well to insert the finger from the median line and raise up the abdominal muscles and skin and make the incision upon the finger, so as to be certain to avoid injury to the peritoneum. Evacuation of pus, mild irrigations, and the use of antiseptics, such as mercurochrome, may be desirable. In some cases, the prevesical inflammation is in the form of a chronic sclerosis, sometimes very dense in character, which may greatly compress and contract the vesical walls. It may be desirable to partially excise this in order to liberate the bladder. A careful cystoscopic examination will indicate whether it is desirable to open the bladder for simultaneous treatment or drainage, or for operation upon the prostatic orifice.

Abscess external to the lateral walls of the bladder may come from diseases of

the vas deferens, either ordinary infections or tuberculosis, and occasionally from infections of the hip-joint. They may be reached either by prevesical incision in the median line or through one of the recti muscles, or an incision above Poupart's ligament, which follows the course of the vas deferens. Great care must be taken not to tear the peritoneum, particularly in inflammatory diseases of the vas deferens. If a tuberculous abscess forms along the course of the vas deferens following incomplete vasectomy, drainage is important in order to avoid generalization of the tuberculous process. If the abscess points toward or into the inguinal canal, drainage through this region may be entirely satisfactory. If not, an incision along the outer border of the rectus muscle may be more advantageous.

Retrovesical Abscesses.—As stated elsewhere, these may follow ordinary infections and tuberculosis of the prostate, seminal vesicles, ampullæ, and vasa deferentia, or infections within the bladder. In most cases the peritoneal cavity has not been invaded and the abscess lies between the bladder, peritoneum, and rectum. It is generally anterior to the anterior layer of Denonvilliers' fascia, but in some cases this fascia is penetrated and the abscess may extend up along the rectum and behind the posterior layer of peritoneum. Retrovesical extraperitoneal abscesses in this region are best reached by an operation similar to that described for attacking the seminal vesicles through the perineum. After exposing the posterior surface of the prostate and seminal vesicles with the use of the long tractor in the urethra and without opening the urinary tract, the abscess can usually be palpated above and between the upper portions of the seminal vesicles. Incision through the anterior layer of Denonvilliers' fascia may then open the abscess for adequate drainage. It is advisable to put in two or more tubes and to maintain them in position for two or three weeks in order to establish drainage tracts through which pus will be evacuated for a sufficiently long period to get a permanent cure. In some cases, where the infection has traveled upward behind the peritoneum, incisions on one or both sides, above the pelvic brim, to take care of the upward extension of the abscess or extravasation are indicated. Occasionally the retrovesical extraperitoneal abscess is situated high up upon the posterior wall of the bladder and cannot be reached through the perineum. Such cases are apt to follow traumatism of the bladder in which the muscular wall is divided but the peritoneal coat remains intact. In such cases it is often necessary to carry out laparotomy, inspect the posterior wall of the bladder intraperitoneally, and evacuate the abscess. After closing the bladder one should insert a pelvic drain.

Another type of retrovesical abscess is due to inflammation of the urachus. We have seen a case in a child which formed a mass as large as an apple, compressed the bladder, and almost filled the pelvis. Fusiform extension along the course of the urachus gave the clue to diagnosis. It was opened and drained by an extraperitoneal incision.

PERINEAL CYSTOTOMY

Median Operation (Sectio Mediana).—This procedure, which was inaugurated by Jean des Romains, and which Maranus Sanctus and the Collot family popularized, is now only interesting historically. It was used by the early operators for the removal of calculi from the bladder. An incision was made in the median line of the perineum, from the beginning of the scrotum backward to within 1 cm. of the anus. The skin and subcutaneous tissues were then divided upon a grooved sound. The lithotome was introduced into the groove of the sound and carried

up to the bladder. If the dilating lithotome was used, the blades were then separated and the instrument withdrawn, enlarging the wound as it came out. The neck of the bladder, prostatic and membranous urethra, as well as the external sphincter, were usually divided. Through this incision, stone forceps were inserted and the removal of calculi carried out. The operation fell into disrepute on account of the frequent injury of the rectum and incontinence of urine which often followed.

Lateral Perineal Cystotomy.—This operation was introduced by Celsus and first practised successfully by Frère Côme in 1748. A grooved sound was introduced through the urethra until it entered the bladder. The beak of the instrument was then turned markedly to the right and an incision was made to the left of the median raphé obliquely backward, the anterior end being about 3 cm. distant from the anus and the posterior end about midway in a line which extends from the anus to the tuberosity of the ischium. This incision extended deeply until the index-finger of the left hand introduced into the wound felt the groove of the instrument through the urethral wall. The surgeon then introduced a bistoury, opened the urethra upon the grooved sound, and introduced the lithotome with which the prostatic urethra and vesical neck were cut, after which stone forceps were introduced as in the median operation.

Cystotomy, Prerectal Bilateral.—To Nélaton belongs the prerectal incision, that is to say, a transverse incision made in front of the anus, followed by separation of the anterior wall of the rectum up to the apex of the prostate. Dupuytren modified this by making a double oblique incision, which began in the median line, midway between the anus and the bulb. The incision was rapidly carried down toward the grooved sound in the urethra and under the guidance of a finger in the rectum the deeper tissues were divided with scissors until one arrived at the apex of the prostate within which the grooved sound could be felt with the finger. At this point an incision was made with the bistoury, the lithotome of two branches devised by Dupuytren introduced and guided by the grooved sound into the bladder. It was then opened out and withdrawn, thus producing a wound through which large calculi could be removed. This operation had the advantage of giving a large wound, avoiding rectal injury and incontinence of urine. It was the direct forerunner of the modern operation for the perineal approach to the prostate behind the triangular ligament and without injury to the external sphincter.

Perineal Drainage of the Bladder.—This is often carried out through a small urethrotomy incision (boutonniere) which may be made either through the bulbous urethra or behind the triangular ligament through the membranous urethra and apex of the prostate. This method of draining the bladder is generally practised through the bulbar incision and care should always be taken not to injure the external sphincter or triangular ligament and thus avoid incontinence.

STONE CRUSHING (LITHOTRITY; LITHOLAPAXY)

The first stone-crushing operation upon the living was done by Civiale in 1822 with his "trilabe" (Fig. 775), and since then the operation of lithotrity has undergone numerous improvements, which we unfortunately have not space to discuss fully. Among those who have contributed largely may be mentioned Weiss, who brought out the first two bladed-instrument, and Heurteloupe, who in 1832 greatly improved the instrument of Weiss. Costello, who produced the first lithotrite in which one blade traveled in the groove within the shaft of the other; Thompson,

who with the great mechanic of Paris, Charriere, developed a screw and clutch in the handle by means of which the stone was first crushed by screw power. The operations were generally done in three sittings, the fragments being passed *per*

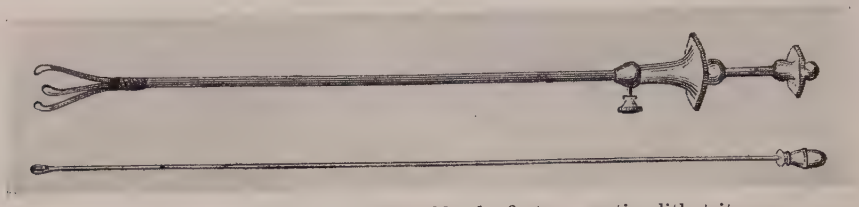
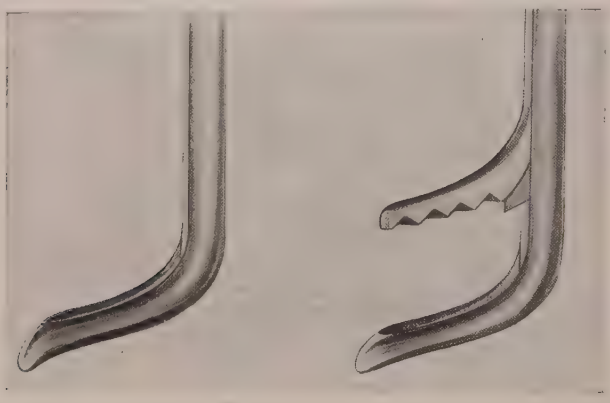
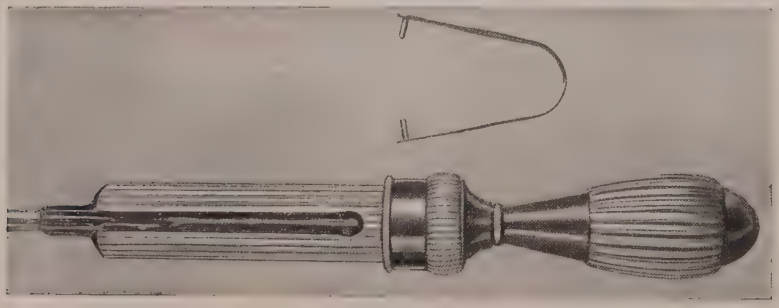


Fig. 775.—Civiale's trilabe. Probably the first evacuating lithotrite.

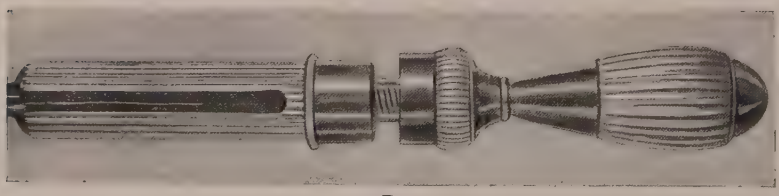


A B

Fig. 776.—The jaws of Bigelow's lithotrite: A, Closed; B, open. Note the shallow female blade and the self-cleaning notches in the male blade. Keen's Surgery.



A



B

Fig. 777.—The handle of Bigelow's lithotrite: A, Closed; B, open. Note the rough serrations which often blister the hands. Keen's Surgery.

vias naturales. In 1878 Bigelow, of Boston, began his remarkable studies and brought out his series of lithotrites which were much stronger than had ever been produced before, and so designed that they would not injure the bladder

(Figs. 776, 777). He discarded the fenestrated female blade and replaced it by a solid shallow blade, thus avoiding injury to the mucous membrane from fragments. He also lengthened the female blade so as to minimize the danger of picking up the mucous membrane between the two blades. His third great addition was the introduction of a powerful evacuating bulb (Fig. 778), and he laid stress upon the importance of evacuating all the fragments at one sitting. The operation of *litholapaxy* (the name which was furnished by Oliver Wendell Holmes), consists

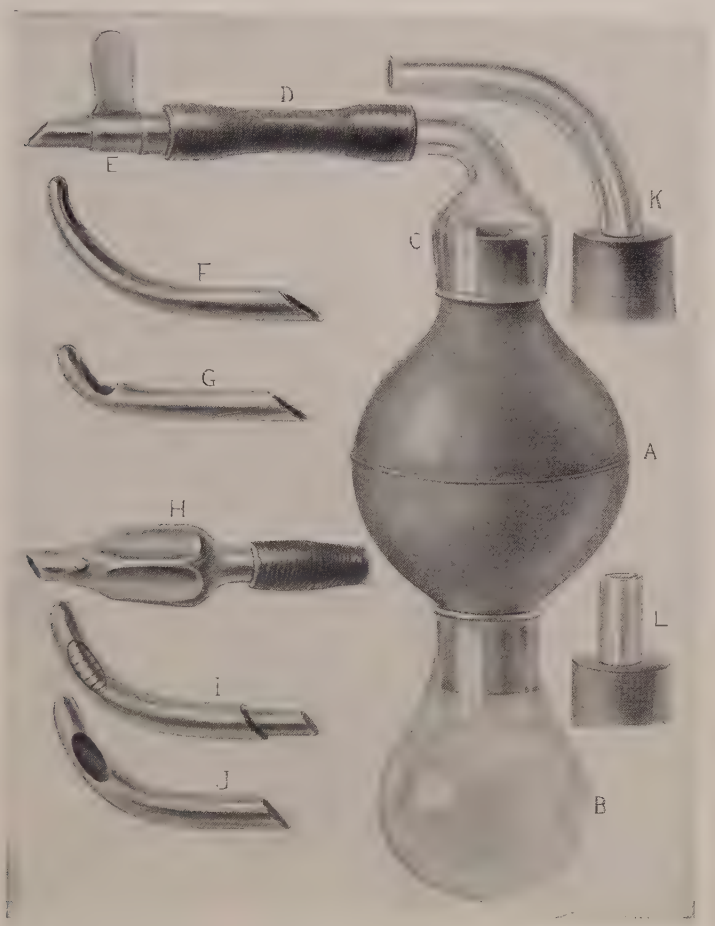


FIG. 778.—Young's simplified evacuator for various uses: A, Rubber bulb, alike at both ends, held by friction contact with receptacle B, and upper connection C, which is attached by heavy rubber tube D with evacuating tube E. A curved interior tube K, of either glass or metal, may be used instead of C. A straight tube, L, may sometimes be preferable (kidney pelvis, collecting stomach contents, etc.). F and G, Types of Bigelow evacuators. H, I, and J, French evacuating tube with spiral obturator.

of crushing and evacuating at one sitting all calculi, and should be known as the operation of Bigelow, who is undoubtedly the father of the modern operation of stone crushing. The more recent history of stone crushing embraces the important papers and additions of technic by Guyon of Paris, Chismore of San Francisco, and Freyer and Keegan of India (who performed the operation of litholapaxy upon thousands of children). Chismore's contribution is important in that he brought out the first lithotrite by means of which the fragments could be evacu-

ated through the shaft without removal of the instrument. This instrument is shown in Figs. 779 and 780. With this instrument, Chismore operated successfully on a long series of cases, and justly claimed the great advantage that he was able to draw into the blades of the instrument the last fragments, and thus avoid leav-

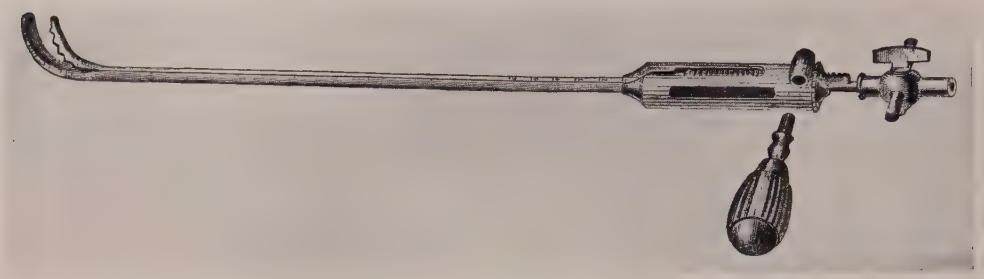


Fig. 779.—Chismore's evacuating lithotrite. Note the inconvenient mechanical details of the outer portion.

ing behind fragments as nuclei for formation of more calculi. We, in 1908, set about to construct an evacuating lithotrite which would not only be better mechanically, but possess a larger interior for evacuation, and through which cystoscopy could be carried out. The cystoscopic evacuating lithotrite, as shown in

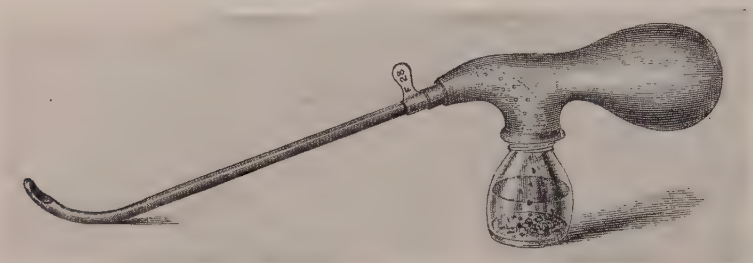


Fig. 780.—Chismore's evacuator. The perforated curved tube inside the rubber bulb keeps the fragments in constant motion during evacuation.

Fig. 781, has the same general shape as that of the instrument of Bigelow, the blades being modeled after his designs. The shaft of the instrument is much larger, and consists of two tubes which carry the male and the female blades. The handle of the instrument is designed with larger concave surfaces, so as to afford a better grip and to avoid abrasion of the operator's hands. Within an outer cap of the

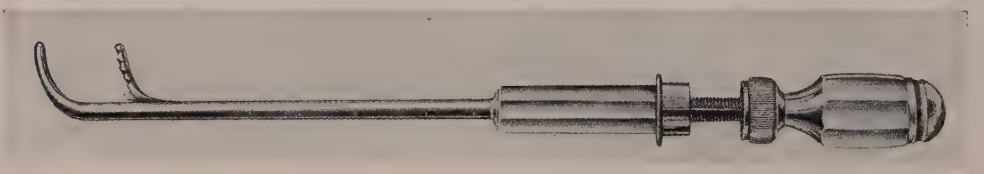


Fig. 781.—Young's evacuating cystoscopic lithotrite, open as in use without cystoscope.

handle, a concealed cock is present, which closes the evacuating tube. An especially light evacuator was designed so that it might be attached to the instrument during operation and used simultaneously to evacuate fragments or to draw them within the grasp of the blades for further crushing. A long cystoscope was provided, by means of which the bladder could be explored, and fragments grasped (Fig. 782).

The Technic of Litholapaxy.—*Anesthesia.*—General anesthesia, especially in children, is preferable, but the operation may also be carried out under spinal, caudal, or local anesthesia. In children, or where the stone is large or very hard, general anesthesia is desirable. In other cases local anesthesia may be entirely

Fig. 782.—Young's evacuating cystoscopic lithotrite: I, Evacuator attached to lithotrite. The stop-cock, B, can be opened and closed while the evacuator is attached. II, Long straight cystoscope inserted through lithotrite for examination of bladder. Beak of lithotrite closed, held against the anterior wall while the search is made for calculi with the cystoscope. III, Blades separated, cystoscope looking out between the blades as when about to pick up a fragment.

satisfactory and we have removed a majority of calculi by litholapaxy in this way. After evacuating the bladder with a catheter, 5 c.c. of 4 per cent. novocain is introduced into the bladder and equal amounts into the posterior urethra and the anterior urethra, as the catheter is withdrawn. It is often desirable also to give the patient a hypodermic injection of morphin (grain $\frac{1}{8}$ to $\frac{1}{4}$). Cocain gives a better

anesthesia, but is certainly more dangerous, and if used should be carefully washed out from urethra and bladder before the lithotrite is introduced.

Position of Patient.—The customary position for cystoscopy with the legs separated, thighs and legs partially flexed, is in our opinion the best position. This allows the operator to stand between the thighs and gives abundant room for the use of the evacuator in varying positions. A catheter is introduced and about 200 c.c. of fluid (if possible) is introduced within the vesical cavity. The lithotrite is then passed until the beak arrives against the posterior wall of the bladder, when gentle pressure is made so as to produce a pouch behind the trigone into which the rest of the bladder will naturally drain (Fig. 783). Holding the instrument in this position by grasping the handle of the female blade firmly with the left hand, the male blade is slowly drawn outward (for an adequate distance, 3 to 5 cm.) so as to allow the calculus to roll down the inclined vesical plane upon the female

Fig. 783.—Lithotrity. The beak of instrument is pressed against posterior wall of bladder and held there with the left hand. The blades are separated with the right hand and then approximated, often grasping the stone, which is immediately fixed by clutch and then crushed. Gloves should be worn.

blade in the depression on the posterior wall of the bladder. Holding the female blade in this position, the male blade is pushed slowly downward until it is arrested by the calculus which has rolled into position beneath the two blades (Fig. 784). The operator then turns the clutch which engages the screw of the male blade and proceeds to crush the stone without moving the female blade from the posterior wall of the bladder, but being careful not to traumatize it.

Having broken the stone completely and brought the blades into apposition (as shown by observing the handle externally) the procedure of separating the blades, bringing them together, catching a fragment, fixing the clutch, and crushing the stone is repeated. This is carried out without changing the position of the blades as long as the operator is confident that important new fragments are being crushed. At times it may be desirable to have an assistant shake the pelvis of the patient so as to cause fragments to roll down upon the depressed female blade.

If difficulty is experienced in catching calculi or fragments, the female blade may be slowly turned to one side or the other, while still being pressed against the posterior wall of the bladder, and attempts to grapple calculi are made in these positions. If the instrument is turned markedly to either side, there is danger of the mucous membrane of the bladder wall being caught between the two blades. To avoid this, the instrument, after catching something (supposed to be a calculus) should be rotated toward the median line. By this maneuver it at once becomes apparent whether the mucous membrane is caught or not.

Having thoroughly broken up the calculus or produced a large amount of detritus, evacuation should be begun. If the Bigelow type of lithotrite is being used,

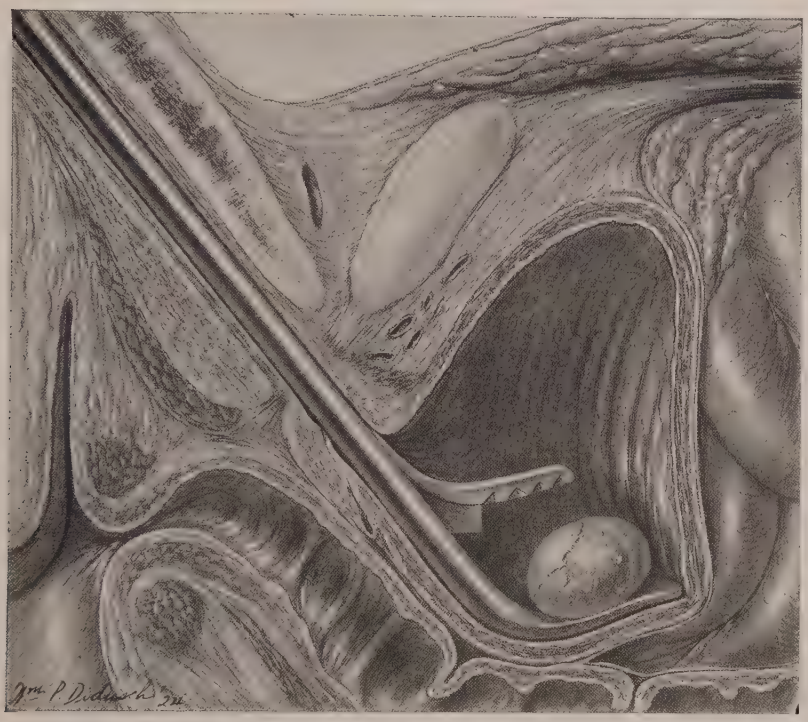


FIG. 784.—Lithotrity. The bladder is depressed by the posterior blade forming a funnel which causes the stone to drop down automatically upon the female blade. The male blade in position for grasping and crushing.

it is necessary to withdraw the instrument, introduce an evacuating tube and attach the rubber pump, filled with fluid.

In evacuation it is well here to follow much the same procedure as in the crushing of the stone. The evacuating tube should be carried into the most dependent portion of the bladder, where it is placed against the posterior wall so as to produce a dependent pouch into which the fragments will roll. Holding the evacuating tube in the left hand and the evacuator in the right between thumb and fingers, the bulb is compressed (systole) and then quickly released (diastole). Small fragments will soon be seen tumbling into the glass receptacle.

This operation is repeated, with the beak at the same position, as long as fragments continue to fall into the glass bowl. The beak may then be turned by means of the external handle to one side or the other in search for remaining fragments.

A general search of the bladder may then be begun with the beak in varying positions. If the prostate is enlarged, it may be advisable to turn the beak down behind the middle lobe. The same thing may be true in the presence of hypertrophy of the trigone. Where the bladder is trabeculated, it may be necessary to search for fragments in various parts of the bladder in order to empty it completely.

Not infrequently one finds after evacuating a certain amount of detritus that fragments too large to pass through the evacuating tube are present. This fact will be recognized by a clicking sensation, during diastole, which will at once be recognized as different from the sensation produced by the orifice of the evacuating tube becoming suddenly stopped up by a stone fragment. Stoppage may also be due to the mucous membrane being sucked into the orifice of the evacuating tube. This "fish-bite" which occurs when the bladder wall is drawn into the opening is soon recognized and is readily avoided by changing the position of the beak or introducing more fluid into the bladder.

Having determined that additional fragments or stones are present in the bladder, the lithotrite is reintroduced and the operation carried out as above described. If the calculus is large, it may be necessary to repeat this several times. The detritus is often so great as to require many evacuations and reintroductions of the lithotrite before the stone is completely crushed and evacuated.

In the presence of irregularities of the bladder, trigonal enlargements, pouch formation, and hypertrophied prostatic lobes, the difficulties of the operation are greatly increased and the danger of leaving fragments or even whole calculi is fairly considerable. It is on this account that Chismore introduced his evacuating lithotrite. The same reason caused us to attempt to devise a more powerful and practical instrument and to introduce a straight cystoscope through the instrument to discover and pick up remaining fragments.

Litholapaxy with Young's evacuating lithotrite is carried out as follows: The bladder having been filled with fluid (200 c.c.) the lithotrite is introduced until the female blade is against the posterior wall of the bladder which is depresssed by it while the instrument is opened out and the operation of crushing carried out as above described. The maneuver is repeated until it is evident that a considerable amount of detritus has accumulated. The evacuating bulb, filled with fluid, is then attached to the lithotrite after removing the external cap (Fig. 782, I). The cock upon the evacuating tube is opened, and evacuation begun as above described. After a time it will be evident from clicking sensations that large fragments are being drawn into the evacuating space between the two blades, and the instrument is immediately closed upon the fragments which are crushed and then immediately evacuated or the crushing continued until more detritus has accumulated.

In this procedure it will be observed that the lithotrite remains *in situ* until the operation of crushing and evacuating is complete. The procedure is facilitated greatly by the co-operation of a well-trained assistant who manages the evacuating bulb while the operator manipulates the lithotrite. Team-work may be perfected so that the sequence of evacuation, crushing and evacuation, may proceed consecutively and rapidly as fragments are drawn between the blades, crushed, and evacuated.

With this instrument, we have generally been able to crush even fairly large stones at one sitting with one introduction of the instrument under local anes-

thesia and with little or no hemorrhage. The avoidance of bleeding is important as coagula may interfere considerably with crushing and evacuation. In some instances we have successfully employed the cystoscope at the end of the operation to examine the bladder for other stones or fragments. Not infrequently there was so little bleeding that fairly good cystoscopy could be carried out.

Simultaneous crushing and evacuation as carried out by the evacuating cystoscopic lithotrite has undoubtedly many points of advantage. The one disadvantage is that the instrument cannot be constructed quite so powerfully as the large Bigelow lithotrites which were used for great oxalate calculi, which are rarely seen today. With the use of cystoscopy and *x*-ray in diagnostic study of a case, one is forewarned of the presence of a very large hard calculus and if litholapaxy is to be attempted, a very large powerful Bigelow may be chosen. Ordinarily, however, the evacuating lithotrite will take care of all calculi that are appropriate for the crushing operation and the procedure is certainly much faster and more satisfactory with the modern instrument than with the Bigelow apparatus.

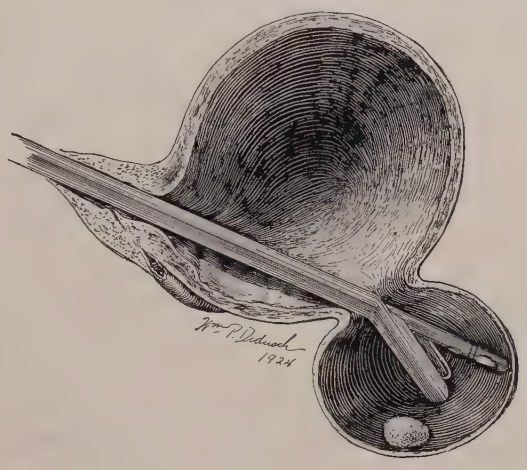


Fig. 785.—Removal of a calculus from a diverticulum by means of Young's cystoscopic rongeur.

Litholapaxy is now rarely carried out in cases of prostatic hypertrophy. In such cases, the stone is removed along with the hypertrophied prostate, by the suprapubic or the perineal route. The cases, therefore, in which litholapaxy is now carried out are far simpler than in the old days, except in the case of children where the same difficulties exist.

Although Freyer, Keegan, and other operators in India and in the Far East have shown conclusively a lower mortality for litholapaxy in children as compared with the suprapubic cystotomy for stone, the surgeon of today refuses to carry out the very prolonged operation of litholapaxy in cases of large calculi and prefers a quick removal by suprapubic incision. The operation of litholapaxy is also contraindicated in encysted calculi, bladders that are markedly trabeculated or cellular in character and in the presence of diverticula. For a small calculus in a diverticulum a cystoscopic lithotrite or rongeur may be entirely appropriate. Under visual observation we have frequently picked up calculi and removed them from diverticula with our cystoscopic rongeur (Fig. 785). Litholapaxy is still the operation of choice for small or moderate size calculi in older children and for calculi

in adults when uncomplicated with ureteral or prostatic obstruction, or marked irregularities of the bladder. In all cases where the stone is very large and very hard (oxalate) lithotomy is yet to be preferred.

OPERATIONS FOR INCONTINENCE

Operative treatment of incontinence of urine varies in accordance with the condition present and the cause. Aside from the enuresis or incontinence of child-

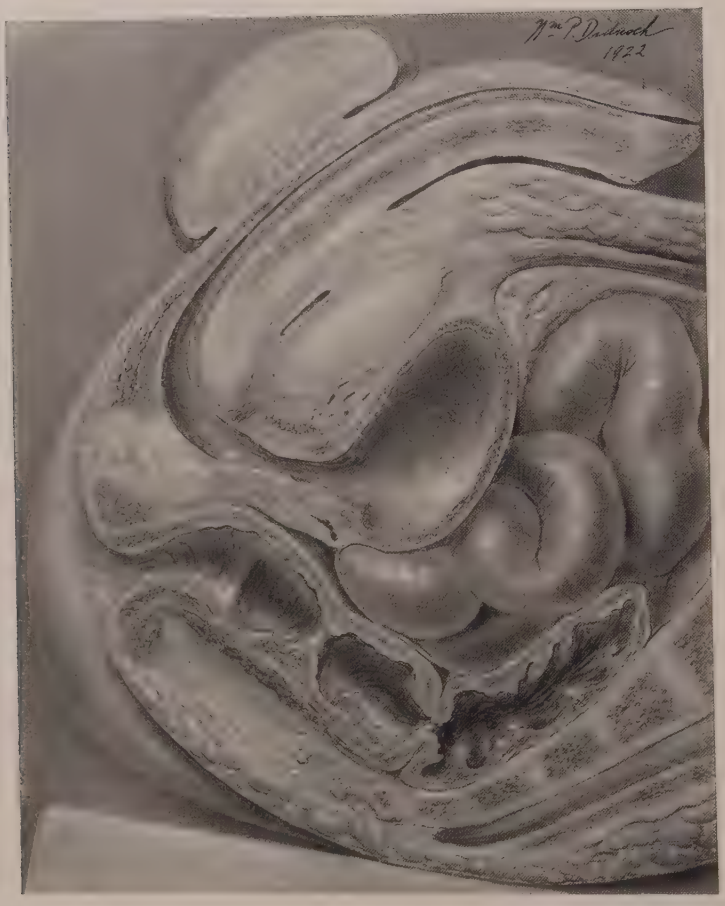


FIG. 786.—Longitudinal section showing condition present in postoperative incontinence. Scar tissue in perineum, external sphincter and membranous urethra widely dilated. Vesical sphincter and prostatic orifice dilated, with scar posteriorly. B. U. I. 2708.

hood (also occasionally in adult life), in which circumcision will often effect a cure, it is frequently seen as a result of prostatic hypertrophy with residual urine (paradoxical incontinence). Incontinence may follow trauma, such as rupture of the urethra, fracture of the pelvis, or injury of the urethral sphincters by perineal or suprapubic operation. Incontinence is also seen in cases of vesical perineal fistula, and cases of calculus of the prostatic or membranous urethra. We have seen 1 case resulting from a prevesical dermoid cyst which opened into the bladder and also from a fistula in the groin through which urine escaped.

It is thus seen that the operative technic required to cure incontinence of urine varies greatly. We shall take up first postoperative incontinence.

Postoperative incontinence is of several types. It may occasionally follow perineal prostatectomy and also suprapubic prostatectomy, median or lateral lithotomy, and operations for division of urethral strictures in which the sphincters have been divided or permanently injured at operation. In all of these cases the condition discovered on examination is practically the same; namely, a dilation of both internal and external sphincters with failure of the musculature in those regions to prevent the outflow of urine (Fig. 786).

Operative Technic for the Radical Cure of Incontinence.—In 1908[1] we reported a new radical operation for the cure of incontinence of urine which we had carried

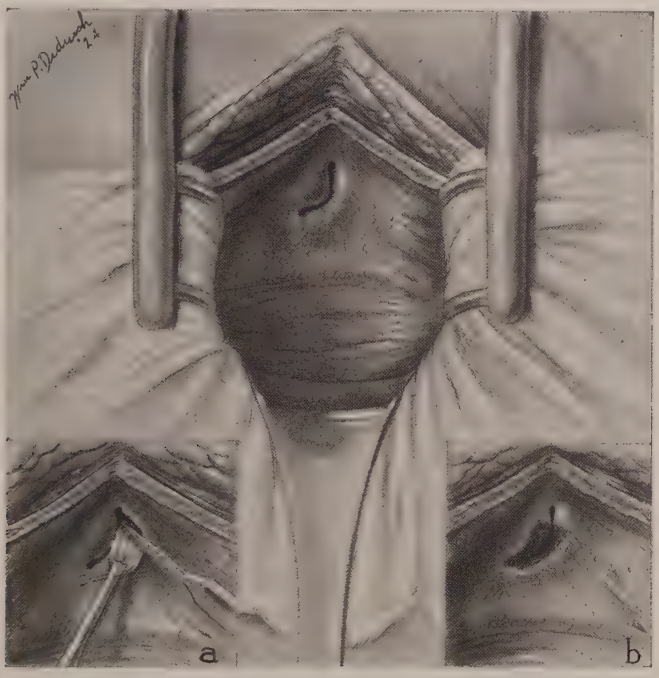


FIG. 787.—Young's combined suprapubic and perineal plastic operation for incontinence. Internal sphincter seen enlarged by previous lateral lithotomy. *a*, Excision of scar tissue and adjacent mucosa. *b*, The normal portion of urethral orifice is shown above the wound prepared for suturing. B. U. I. 12,901.

out on January 6, 1907, upon a young man in whom both sphincters had been divided by perineal operation for spasmodic pain. Since then we have employed this same operation upon 10 cases of incontinence, some of which followed perineal prostatectomy and 1 suprapubic prostatectomy, 2 median perineal prostatectomy, and others non-operative traumatism. The technic which is practically the same for all cases may be briefly described as follows:

With the patient in the Trendelenburg position the bladder is opened through a 4-inch skin incision and well retracted so as to afford abundant room for inspection and manipulation. In all of our cases but one the urethral orifice was in the form of a vertical slit, in some cases with the lateral margins coapted, in others with the urethra wide open so it was possible to view the verumontanum. In 1

[1] Young: Transactions of the Southern Surgical and Gynecological Association, 1908, xx, 120.

case the aperture was L shaped following perineal lithotomy (Fig. 787). In some cases the trigone was more or less completely divided, the ligamentum interuretericum absent in the median line and the ureters drawn widely apart.

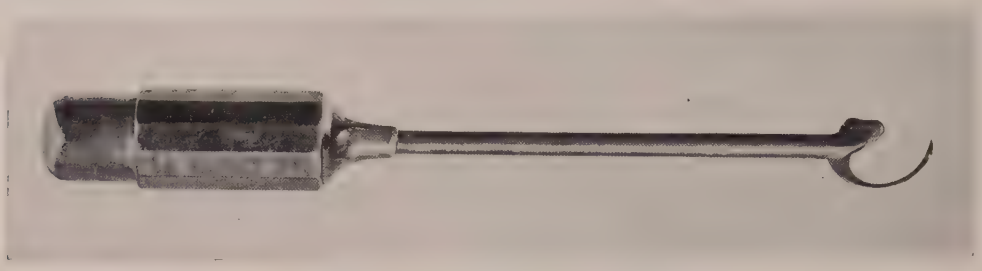


Fig. 788.—Young's boomerang needle-holder.

Palpation with the finger showed an absence of the usual elevation in the region of the uvula vesicæ and the muscle retracted to each side. We have found it best

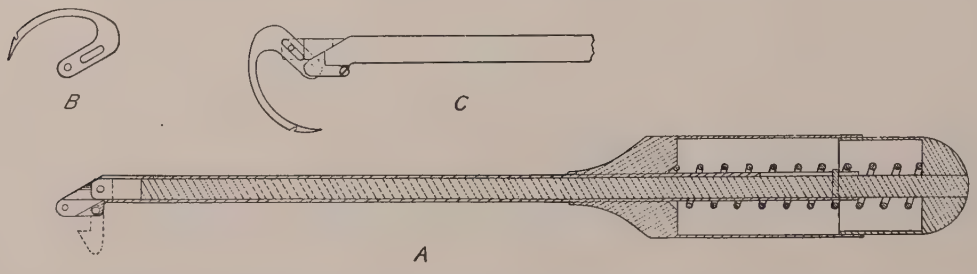


Fig. 789.—*A*, Longitudinal section of "boomerang" needle-holder (with needle detached) showing spring in handle, which is compressed by the hand to cause the point of the needle to penetrate into the tissues and return toward the operator and which, when released, draws the needle back through its tract. *B*, Free needle. *C*, Method of attachment of needle, which is held in place by means of a small clasp, shown opened in *A*.

to pick up the mucous membrane on one side of the urethra with curved toothed forceps and then with delicate long curved scissors to dissect up the mucous mem-

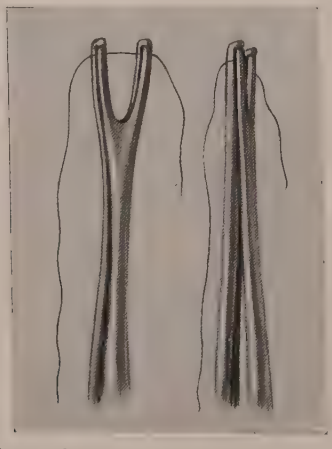


Fig. 790.—Ligature carrier used in conjunction with Young's boomerang needle-holder.

brane and thus denude the lateral and posterior margins of the dilated prostatic orifice (Fig. 787, *a*). This incision should be carried fairly deep so as to reach the

muscle and to excise scar tissue thoroughly. It should go well into the posterior urethra and also include the mucosa of the bladder and adjacent trigone so as to leave a fairly widely denuded area with a surface composed of muscle (Fig. 787, *b*).

Anteriorly, a small amount of normal mucosa, surrounding the urethra in front and for a short distance on each side, remains intact, as shown in Fig. 787, *b*. Having thus secured a good muscular wound for apposition, our "boomerang needle-holder" (Figs. 788, 789) is introduced from the urethra through the posterior part of the left half of the wound. When the needle emerges through the vesical mucous membrane, chromic catgut sutures are promptly hooked over it with the ligature carrier (Fig. 790), and drawn through (Fig. 791). The needle is then in-

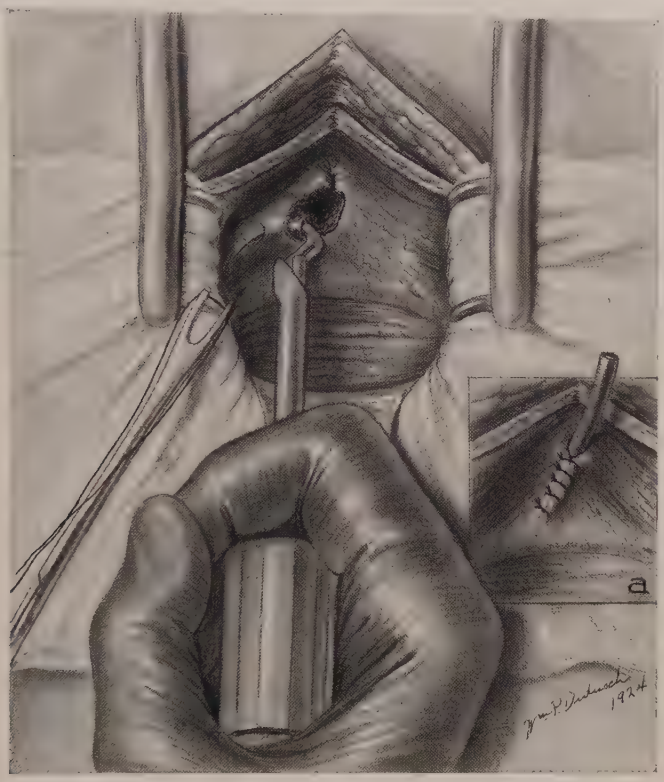


FIG. 791.—Young's vesicoperineal operation for incontinence. The scar tissue and adjacent mucous membrane have been excised at vesical orifice. Suture being placed with boomerang needle-holder with aid of thread carrier. B. U. I. 12,901.

serted on the right side, passing from the bladder into the urethra, where the suture is again picked up and drawn through, thus completing the first stitch, which is not tied until all have been placed.

Similar stitches, 4 to 6 in number, are placed and then tied, thus approximating the denuded margins of the dilated urethra and anterior part of the trigone, and leaving in front only a small, fairly tight urethral orifice as shown in Fig. 791, *a*. The vesical wound is then closed except for a mushroom catheter drain at the upper end, the recti muscles being approximated with silver wire, as described elsewhere.

Operation Upon the External Sphincter.—The patient is then placed in the perineal prostatectomy position, a sound inserted into the urethra, and vertical

incision made in the perineum. In case scar tissue is present this should be followed closely down to the urethra and completely excised, as shown in Fig. 792. The posterior part of the bulb and the membranous urethra are thus opened and any remaining scar tissue surrounding the membranous urethra excised until fairly healthy muscle is discovered (Fig. 793).

The mucous membrane of the urethra will be found to be redundant and this should be excised so as to reduce greatly the caliber of the urethra. Having thus

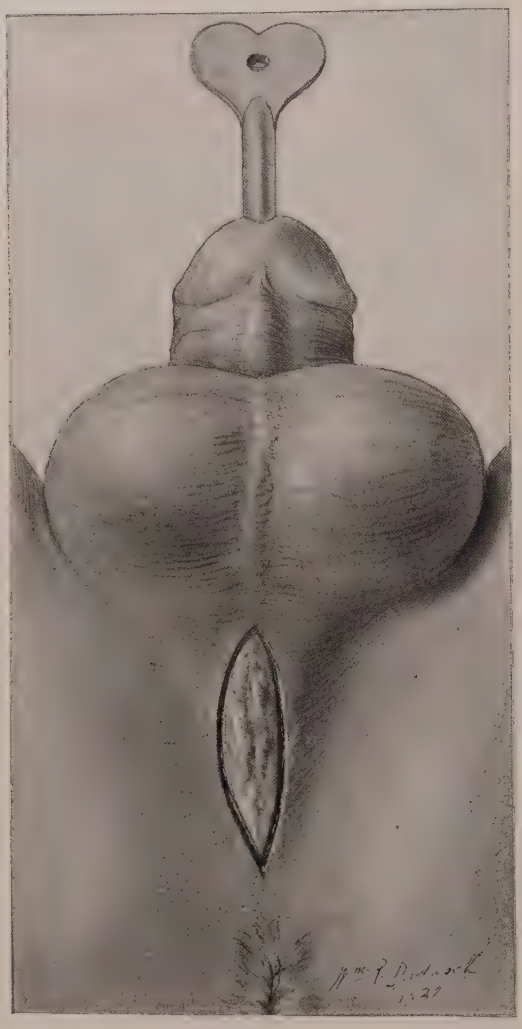


FIG. 792.—Young's vesicoperineal operation for cure of incontinence. Man aged twenty-five years, incontinence of urine following perineal prostatectomy elsewhere. Incision for removal of scar tissue left by median prostatectomy. B. U. I. 2708.

excised the peri-urethral scar tissue and secured good muscle for approximation in the region of the membranous urethra and the bulbous urethra adjacent, the mucosa and submucosa are approximated by a continuous stitch of plain catgut placed upon a small sound in the urethra (Fig. 793, *a*).

A heavy chromic catgut is next used to draw together the muscle from each side and thus cover the urethra with a thick layer of muscle in the region of the

membranous urethra. In most cases we have found it wise to draw the muscle together in two layers so as to form a thick, firm mass. A third layer of sutures is placed to draw together the fascia and subcutaneous tissues.

The skin is closed by a continuous catgut suture or clips, but a small area is left at the anterior angle for a protective drain. It is very important that should any subcutaneous infection occur it be allowed to drain and it is, therefore, necessary

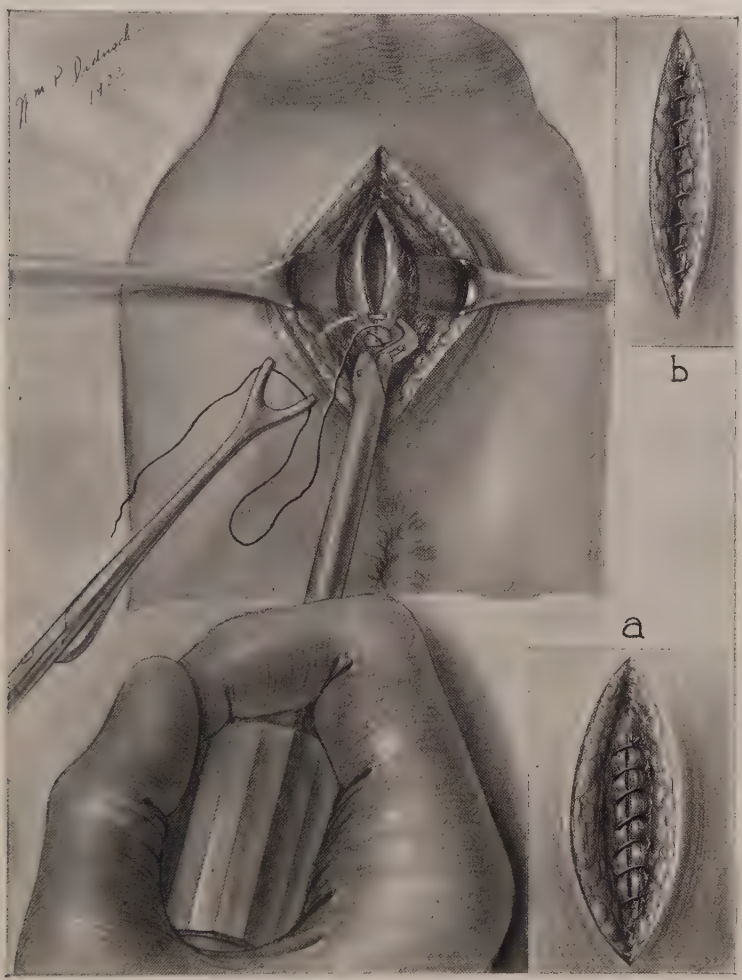


FIG. 793.—Closure of urethra after excision of perineal scar tissue is here shown. *a*, Second line of deep sutures, approximating muscle. *b*, Fat and subcutaneous fascia approximated with continuous catgut. Skin left open for drainage. Result, cure. B. U. I. 2708.

that the skin not be completely closed. The same rule follows for most plastic operations upon the perineum where the ultimate healing of the deep tissues is far more important than the skin. No urethral catheter is provided, the urine being drained from the bladder suprapubically.

Subsequent Treatment.—Suprapubic drainage is retained for about eighteen days. During this time the bladder is treated antiseptically to prevent calcareous deposits upon the tube. About three weeks after the operation it is wise to pass a filiform through the urethra into the bladder and to dilate the urethra gently

with successively larger Le Fort followers. In case a filiform cannot be passed it may be wise to make use of small sounds which must be introduced very carefully, hugging the roof of the urethra in order not to cause severe trauma to the sutured sphincters.

In one of our cases it was impossible to introduce any instrument through the urethra, and we, therefore, inserted a cystoscope in the suprapubic fistula and were able to pass a ureteral catheter retrograde from the bladder. Into this we inserted a filiform, and on withdrawing the ureteral catheter, pulled the filiform through the strictured area into the bladder, and after this dilated the urethra with followers. In some cases very little additional dilation was necessary. In others it was found advisable to pass filiforms and followers for a period of several weeks until the overtightly closed sphincters obtained their elasticity and proper dimensions. The suprapubic fistula has invariably closed.

Results.—The results obtained by this radical procedure have been extremely satisfactory as shown in the cases cited below:

The *first case*, B. U. I. 1502, one of complete incontinence following median perineal urethrotomy and prostatotomy for pain in the urethra, was operated on now over eighteen years ago. He was seen recently and was in excellent condition, with perfect control and normal urination.

In the *second case*, B. U. I. 2726, upon whom, at the age of forty, someone did a perineal operation and removed the entire prostate *en masse*, the internal and external sphincters were both dilated and there was incontinence. A typical operation was done and the immediate result was excellent. When he left here the wounds were closed and the patient had complete control, and practically normal urination. After returning home he had no medical treatment, the operative wound gradually contracted in the bulbomembranous region, he developed stricture, and the suprapubic wound reopened. We have not heard from him since.

Remark: In this case it is evident that the patient should have had periodic dilatations with filiforms and followers, as were used successfully in the first case.

The *third case*, B. U. I. 5105, was one of incontinence following perineal prostatectomy elsewhere. Examination showed both sphincters had been injured and the urethra was dilated in these regions. The usual operation was carried out with immediate success, but, as in the previous case, a stricture formed in the bulbomembranous region and became impermeable so that another operator thought it was necessary to carry out perineal urethrotomy, which resulted in incontinence again.

The *fourth case*, B. U. I. 10,000, aged fifty-two, had had burning and frequency of urination for twelve years. Two years previously one physician stretched the neck of the bladder through a suprapubic operation and, as this did not relieve him, another physician carried out external urethrotomy which resulted in incontinence. Our plastic operation upon both external and internal sphincters was carried out. During the second week the suprapubic fistula healed and patient voided naturally with good control through the urethra, but after this urination became increasingly difficult and the suprapubic wound reopened. Examination: No. 12 metal catheter passed through the bulbomembranous region without difficulty, but met an impassable obstruction at the neck of the bladder. Cystoscope was passed into the suprapubic wound. Under observation through it a small sound was passed by the side of the cystoscope into the bladder and under cystoscopic guidance it was passed through the prostatic orifice into the urethra. After that no difficulty was encountered in passing filiforms and followers. A note five weeks after operation stated that the wound was perfectly healed, the patient had excellent control, and voided urine normally at intervals of six hours. November, 1924, letter: Result of operation excellent. Voids urine at intervals of about four hours. Perfect control. Has had no subsequent dilatations.

The *fifth case*, B. U. I. 12,109, was that of a man who, at the age of twelve, underwent a perineal operation for stone in the bladder. Since then he has had complete incontinence. Examination showed the internal sphincter and trigone divided posteriorly as well as the external sphincter. February 8, 1924, operation, Young, double plastic upon both sphincters for cure of incontinence. During the second and third weeks after operation the patient occasionally

passed urine through the urethra, but, as the suprapubic wound remained open on the twenty-fifth day after operation, an attempt was made to pass filiforms and followers. Filiforms went through the bulbomembranous urethra, but were arrested at the prostatic orifice. With great care, a small sound (about No. 10 F.) was passed into the bladder. The operator took the precaution to keep the beak against the roof of the urethra and only encountered slight resistance in passing into the bladder. Other sounds were then passed without difficulty. Two weeks later wound was healed, patient voiding urine normally with good control. Filiforms and followers up to No. 28 F. were passed with ease. August 14, 1924, patient returns complaining of difficulty of urination. It is now six months since operation. He has perfect control and sleeps all night without urinating. There is an interval of two hours during the day. Examination showed a slight recontraction of sphincter. Filiforms and followers were easily passed and patient received several dilatations. Subsequent reports: Condition excellent; complete cure.

Conclusions.—It is evident from these cases, although small in number, that incontinence of urine due to traumatic dilatation of internal and external sphincters can be cured by the plastic operation upon both sphincters, which we have devised. Dilatation is necessary in all cases and should be done with great care. In two instances the most pronounced contraction occurred at the vesical orifice and care had to be taken not to break down the artificial bar produced by operation. In one case it was necessary to pass an instrument retrograde with the assistance of a cystoscope in the suprapubic fistula. A procedure used in an epispadias case might be employed with success; namely, to pass a ureter catheter by means of a cystoscope through the suprapubic wound and to insert into its end projecting from the penile meatus a filiform bougie which can then be easily withdrawn back through the strictured area into the bladder and followed by dilatation with dilators.

We have recently carried out a retrograde passage of filiforms by having constructed a short curved cylinder of metal by which two filiforms could be joined together, butt to butt. These were passed through the plastic areas of strictured urethra, retrograde, with a ureter cystoscope, and then drawn out from the meatus until the butt of the second filiform appeared, when the two were unscrewed, and the filiform remaining in the urethra was then used to conduct followers through the artificially strictured areas.

The after-care of these cases is most important and admittedly tedious and difficult, but with meticulous attention by the operator himself the results obtained for these pitiable patients is worth all the effort expended.

CHAPTER XVII

OPERATIONS ON THE PROSTATE

OPERATIVE TREATMENT OF PROSTATIC HYPERTROPHY

Conservative Perineal Prostatectomy.—*Position of Patient.*—An exaggerated dorsal position is the most satisfactory. This may be secured upon the ordinary operating table by placing a large sand-bag beneath the sacrum, forcibly flexing the thighs upon the abdomen and elevating the perineal end of the table. Halsted's perineal board with upright stakes to hold the legs is very satisfactory. We now use a table in which the position is obtained automatically, as shown in Fig. 794.

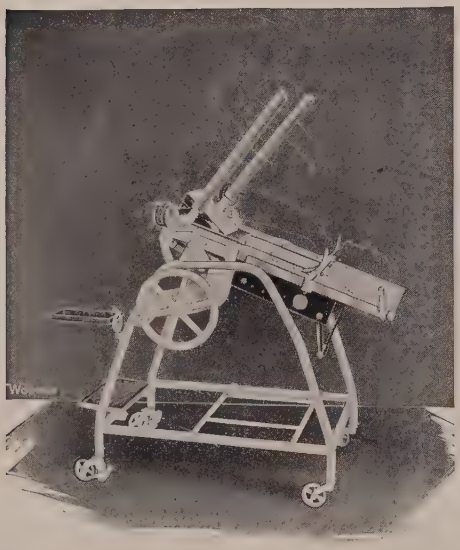


Fig. 794.—Young's urologic table in position for perineal prostatectomy. Note rubber-covered side bars, perineal elevator in use, depression of head of patient.

The *patient is anesthetized upon this table,* generally with nitrous oxid-oxygen or caudal anesthesia, and brought into the operating room in a horizontal position. The feet are then held up and the foot-plate of the table removed. The side bars are elevated after drawing out the retaining pins, and a large rubber tube (water hose 2 inches in diameter) slipped over each of them to protect the skin of the patient. The legs are then lifted up so as to encircle each post. By turning the ratchet mechanism at the head end of the table the shoulder-pieces are gently forced upward, carrying with them the patient and pushing the buttocks upward between the leg supports (Fig. 795). At the same time, the automatic perineal elevator gradually raises up the sacrum until the apparatus reaches the vertical position, after which it is automatically released (Fig. 795). One can then continue to push the patient up by the shoulder-pieces until a splendid exposure of the perineum is obtained. The head of the patient is then depressed by turning the wheel at the side of the table until the perineum is sufficiently elevated, as shown in Fig. 794. A good perineal position is absolutely essential for this operation.

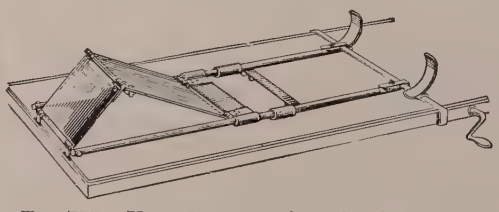


Fig. 795.—Young's automatic perineal elevator.

The skin of the perineum, scrotum, and penis is then thoroughly *rubbed with 2 per cent. mercurochrome in acetone-alcohol* (see Vol. I, page 246) and the *urethra injected with 1 per cent. meroxyl* to sterilize it. A folded towel is placed upon the

abdomen beneath the dorsum of the penis and *a sound is introduced* cautiously through the bulbous and membranous urethra until the tip arrives at about the

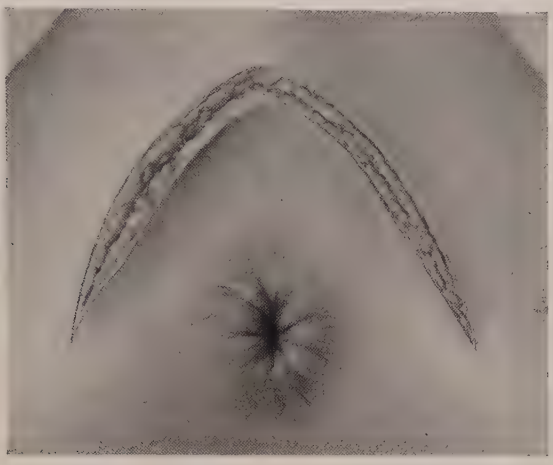


FIG. 796.—Young's perineal prostatectomy: Perineal incision used for prostatectomy.

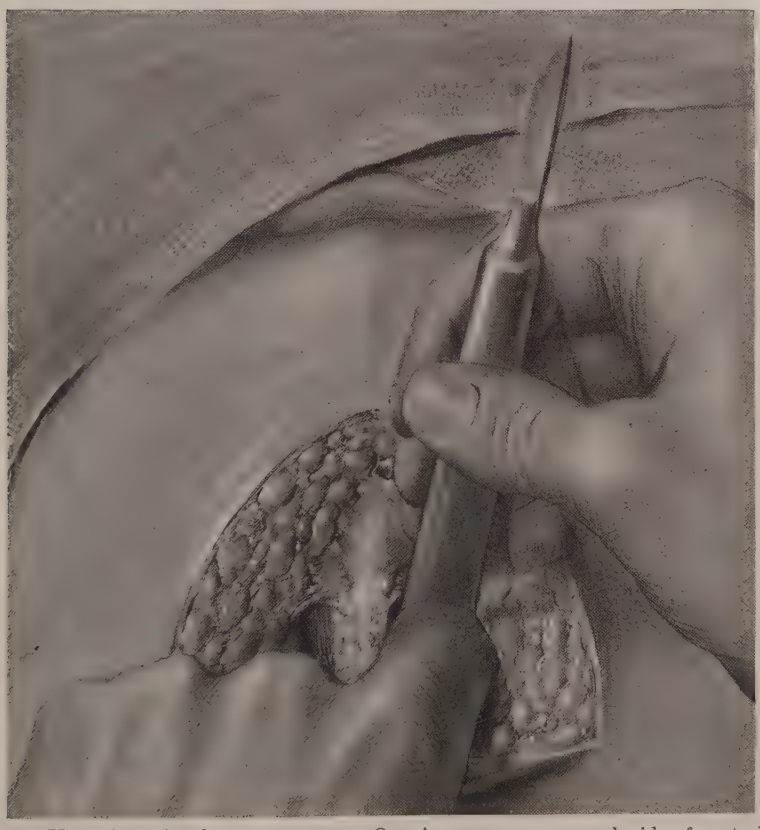


FIG. 797.—Young's perineal prostatectomy: Opening up space on each side of central tendon by blunt dissection with finger assisted by handle of scalpel. Operator careful to go behind transversus perinei and triangular ligament.

middle of the prostatic urethra. An attendant then grasps it through the sterile towel beneath the penis and holds it firmly in position. Towels are then placed

in a triangular fashion so as to cover all but the area of operation, and a special large sheet with pockets for the legs envelops the patient and lower end of the table.

FIG. 798.—Bifid retractor for placing central tendon and recto-urethralis muscle on tension.

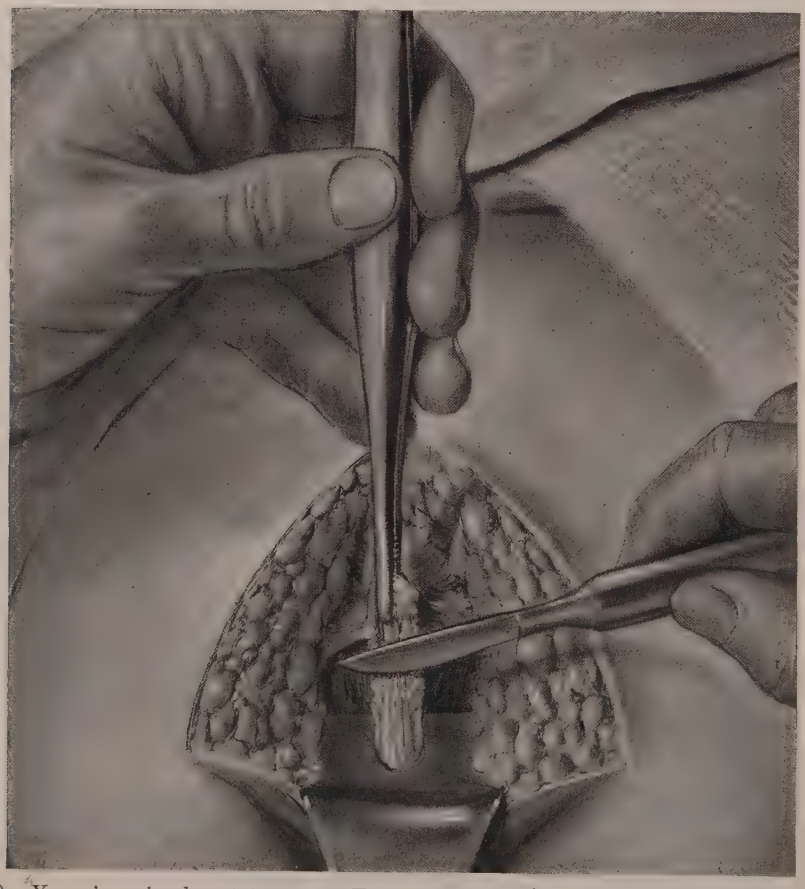


FIG. 799.—Young's perineal postatectomy: Traction made with bifid retractor; division of central tendon just behind bulb.

Cutaneous Incision.—An *inverted* U *cutaneous incision* is now employed. The central portion crosses the median line about $1\frac{1}{2}$ inch (3 cm.) in front of the anus (Fig. 796) and from there curves backward and outward on each side to a point

midway between the anus and the spine of the ischium—each branch of the incision being about 2 inches (5 cm.) long. The fat and subcutaneous fascia are divided freely until it is possible to palpate the bulb in the median line in front and to recognize properly the position of the transversus perinei muscles on each side.

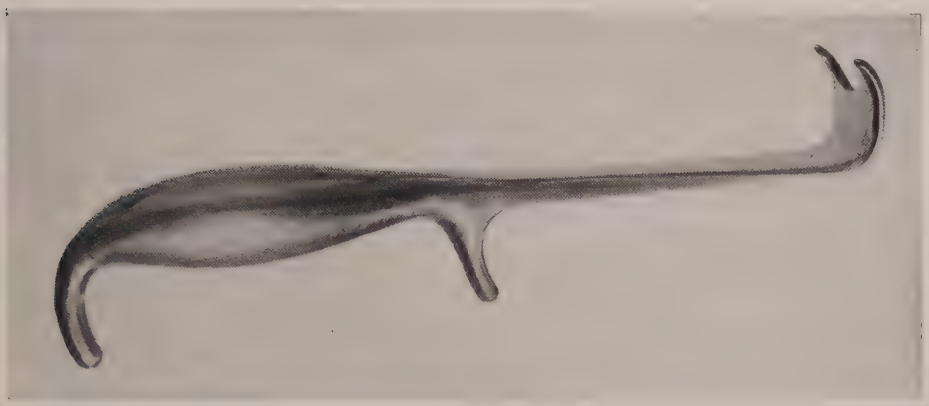


Fig. 800.—Bulb and external sphincter retractor. The notch encircles urethra and draws sphincter forward previous to urethrotomy.

The next step is by blunt dissection to *expose the space on each side of the central tendon* behind the transversus perinei muscles and in front of the curving levator ani muscles (Fig. 797). This space may be easily reached by plunging the finger into the fatty tissues at a point about $\frac{3}{4}$ inch (2 cm.) away from the median line and on a level with the anterior margin of the anus. Pressure is then made outward and slightly forward into the space behind the transversus perinei muscle and triangular ligament beneath it. Much assistance can be obtained by simultaneously using the handle of the scalpel by the side of the right index-finger in producing this hole on each side of the central tendon, and with the handle of the scalpel one can make certain that the transversus perinei muscle is in front of the wound (Fig. 797). (Unless this precaution is taken one may easily get into the triangular space external to the transversus perinei and find himself in the space in front of the triangular ligament instead of behind it. In such a mishap the transversus perinei muscle can be palpated back of the finger, the ischiopubic ramus lies to the outer side and the bulb to the inner side.)

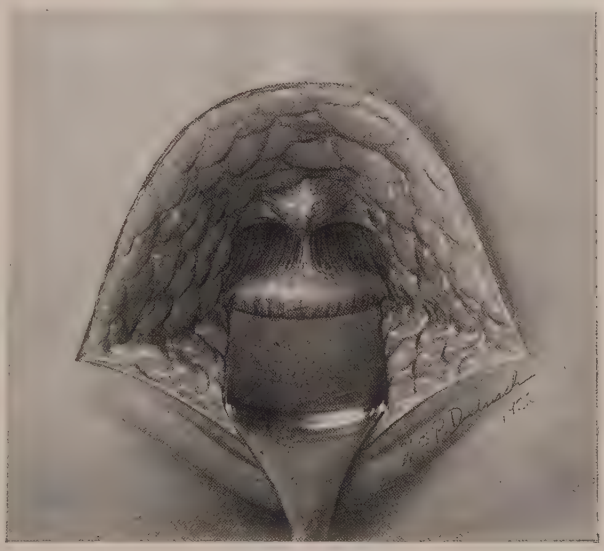


Fig. 801.—Young's perineal prostatectomy: Central tendon divided, recto-urethralis exposed.

The lateral space on the other side is opened up, after which our bifid retractor

(Fig. 798) is introduced. When traction is made upon this the levator ani muscles and rectum are pulled backward and the central tendon drawn taut (Fig. 799).

Division of the central tendon is then carried out close behind the bulb (Fig. 799), which is thus released. In approaching the deeper portion of the wound it is well to insert the finger so as to locate the position of the sound and of the rectum, and to use great care to avoid the latter. If the surgeon is uncertain, a finger may be inserted into the rectum, though we greatly object to this. The bifid retractor is then withdrawn, a simple retractor, without posterior lip, is inserted to draw back the rectum, and a special retractor—which is bifid in character so as to encircle the urethra (Fig. 800)—is inserted and traction made anteriorly.

Division of the Recto-urethralis.—Immediately beneath the deeper portions of the central tendon, which runs between the rectum and the posterior part of the bulb one finds *the recto-urethralis muscle* (Fig. 801), a small amount of fascia usually overlying it. Incising cautiously through this fascia and the muscle beneath, close to the posterior part of the bulb, the longitudinal fibers of the recto-urethralis are finally divided completely, thus liberating the rectum which is retracted and pushed with the handle of the scalpel progressively backward until the membranous urethra is exposed and one approaches the apex of the prostate. In the depth of the wound lie *the two layers of Denonvilliers' fascia*, the anterior attachment of which is to the membranous urethra and triangular ligament on each side. It is necessary to cut through the posterior layer of this fascia before the prostate can be reached. If this is not done, the blunt dissection may lead one into the rectum. Rectal injuries are almost always due to failure to recognize this fact.

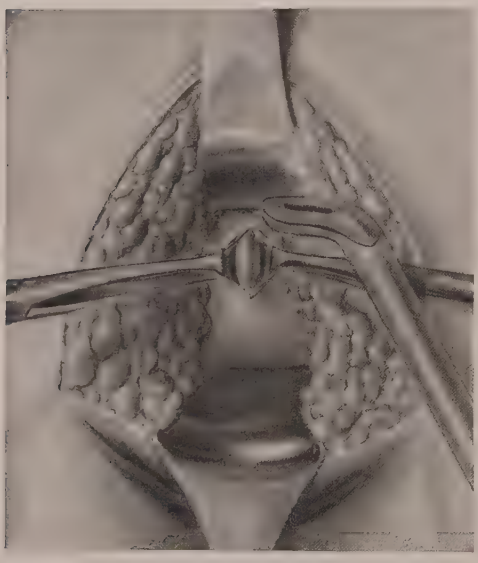


Fig. 802.—Young's perineal prostatectomy: Membranous urethra exposed; bulb retractor anterior, drawing sphincter forward. Incision into urethra at apex of prostate upon sound. Prostatic tractor ready for insertion.

Having divided the posterior layer of this fascia where it covers the membranous urethra, it is possible to push it backward and *expose the apex of the prostate* for a short distance in the median line. We, then, usually find exposed to view about $\frac{1}{2}$ inch ($1\frac{1}{2}$ cm.) of *the membranous urethra*, entirely without sphincteric muscles, which have been drawn forward by the encircling bifid bulb retractor (Fig. 802).

Exposure of Apex of Prostate and Urethrotomy.—Just behind the membranous urethra, the apex of the prostate is seen and the scalpel is plunged through it upon the sound in the urethra, and then carried forward a short distance along the membranous urethra. The urethral sound will then be visible and upon this the edges of the membranous urethra are picked up on each side with Allis clamps or other non-crushing forceps or sutures (Fig. 802). It is essential that the mucosa should be retracted and a good view of the sound within the urethra obtained.

Young's Operation. Insertion of Tractor.—The sound is then withdrawn and a slightly curved sound introduced through the urethrotomy wound into the bladder to make sure that the passage-way is clear, after which our prostatic tractor (closed) (Fig. 803, A) is introduced. Owing to the rather rectangular curve of this instrument, it is best to hold it first with the beak turned downward and the shaft running obliquely until the closed blades are well within the urethrotomy wound. The assistant then removes the anterior bifid bulb retractor

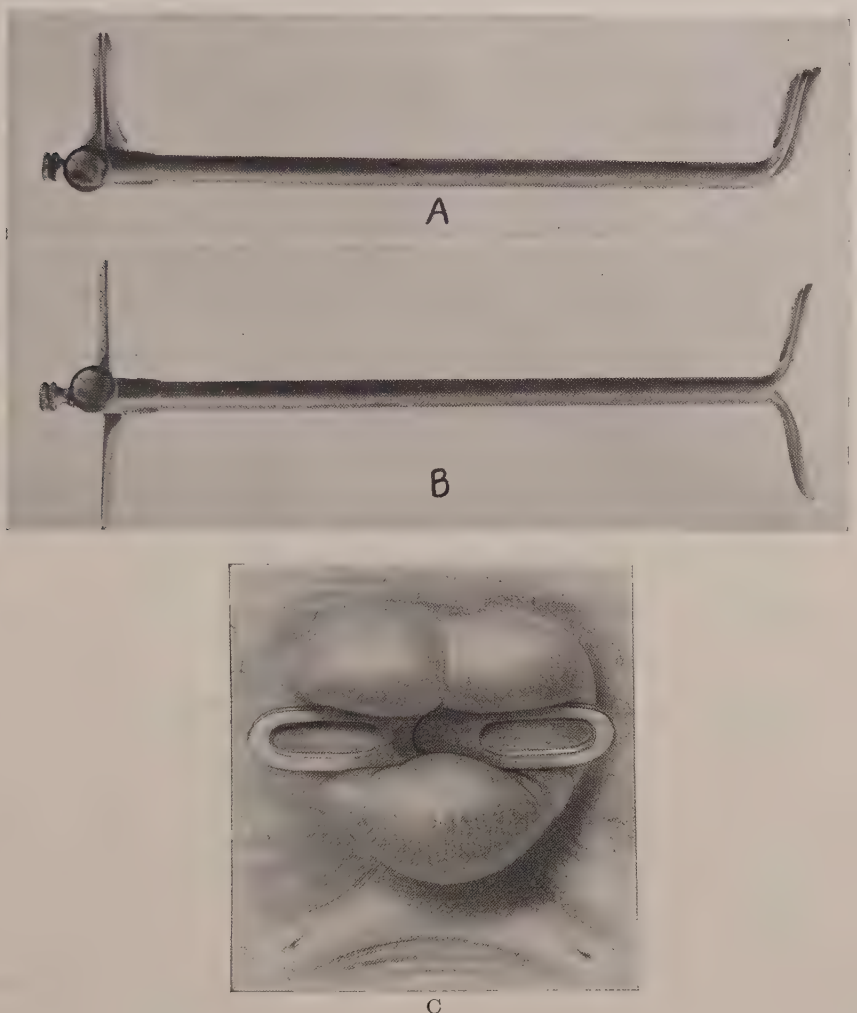


FIG. 803.—Young's prostatic tractor: A, Closed. B, Opened as after introduction into bladder. C, Young's perineal prostatectomy: Position of blades of tractor when prostate is drawn down.

and the handle of the tractor is swung around until it lies against the anterior angle of the wound, while at the same time the instrument is carefully pushed into the bladder and opened out by turning the external handles. The position of the blades in the bladder is shown in Fig. 803, C.

Exposure of the Posterior Surface of the Prostate.—Making traction, the prostate is drawn well up into the wound, but it is still covered by the *posterior layer of*

Denonvilliers' fascia (Fig. 804, *a*), and the deeper portions of the levator ani muscle on each side (levator prostatæ). The rectum is quite close in the median line, and it is, therefore, best to incise carefully upon the apex of the prostate on each side. As the knife passes through the fibers of the posterior layer of fascia (the tissues being pushed back with the handle of the scalpel while so doing) the shiny surface of *the anterior layer of Denonvilliers' fascia* will be recognized. This

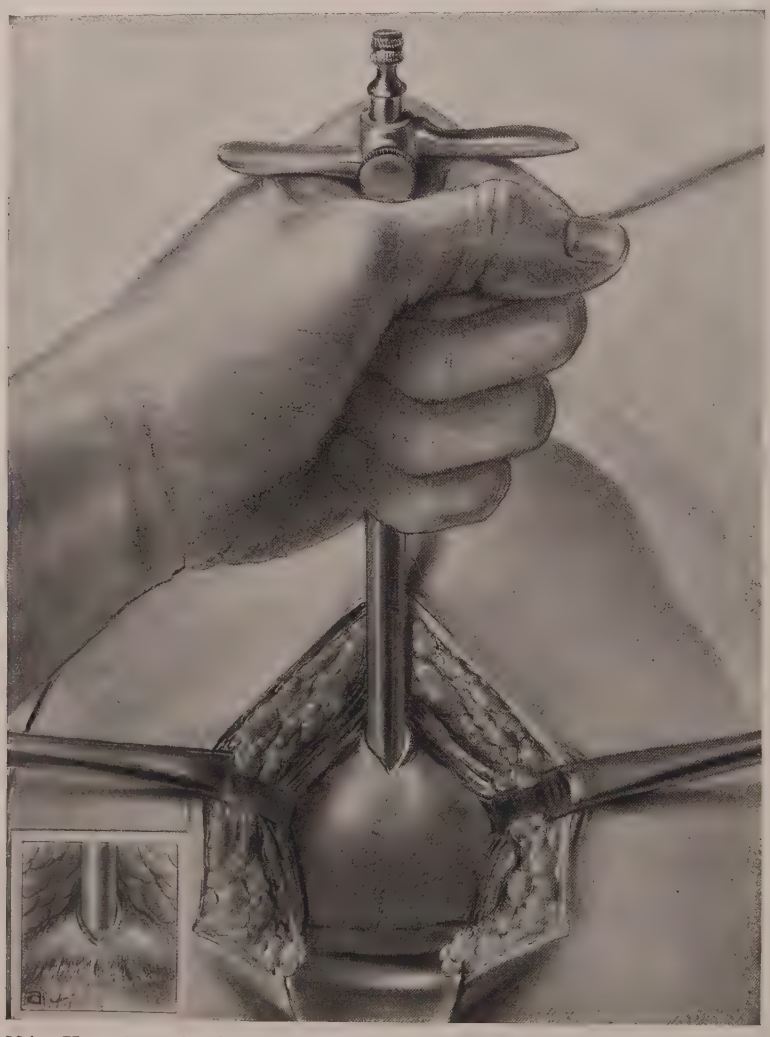


Fig. 804.—Young's perineal prostatectomy: Tractor opened out and prostate drawn down. Posterior layer of Denonvilliers' fascia pushed back with rectum, exposing the prostate covered with anterior layer of Denonvilliers' fascia. *a*, In very adherent cases it is only necessary to expose apex of prostate sufficiently to make incisions for enucleation of lobes.

fascia forms the real capsular covering of the prostate and, by keeping it in view, and pushing the posterior layer of fascia backward with the handle of the scalpel, a space between them ("l'éspace decollable rétroprostatique" of Proust) will be opened up and an excellent view of the posterior surface of the prostate obtained. In the deeper part of this blunt dissection use may be made of the finger but care must be taken to work upon the posterior surface of the prostate and not to push too for-

cibly against the rectum, although it is protected by the posterior layer of Denonvilliers' fascia.

Having thus exposed the prostate, *the levator ani muscles* are forcibly stretched on each side and a blunt retractor (without lip) is introduced in the median line or (preferably) two long slender retractors are inserted in each postero-lateral corner of the wound, while lateral retractors hold the skin and levator muscles apart, and give an excellent view of the prostate (Fig. 804).

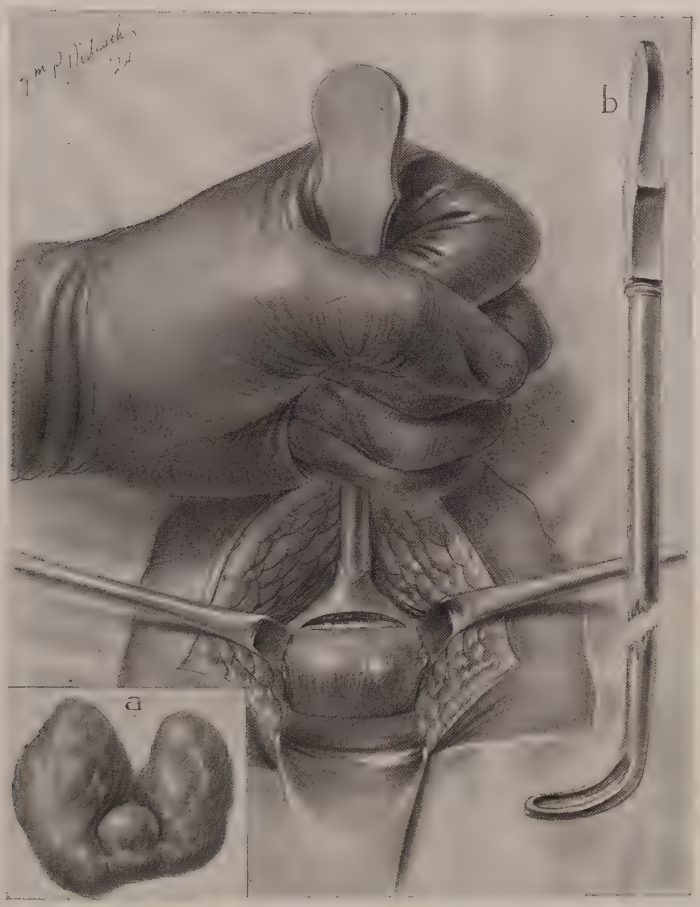


FIG. 805.—First operation with single bladed tractor for perineal prostatectomy (1903). Tractor (*b*) having been introduced through an incision in membranous urethra was turned downward and used to draw prostate down into wound where adenoma was enucleated through a curved transverse incision. *a*, Specimen removed. Lateral and median lobes in one piece.

Incision into Prostate.—The operator has now before him the whole posterior and lateral aspects of the prostate, drawn close to the skin wound by the tractor (in thin subjects). *Various incisions may be employed* and the hypertrophied lobes may be enucleated one at a time or in one piece. In the first operation in which we employed this perineal technic in 1902 a *transverse capsular incision* (Fig. 805) was made and the lateral and median lobes were removed in one piece. Subsequently, with the desire to preserve effectively the verumontanum and ejaculatory ducts, *bilateral capsular incisions* were used (Fig. 806) and some 800 cases op-

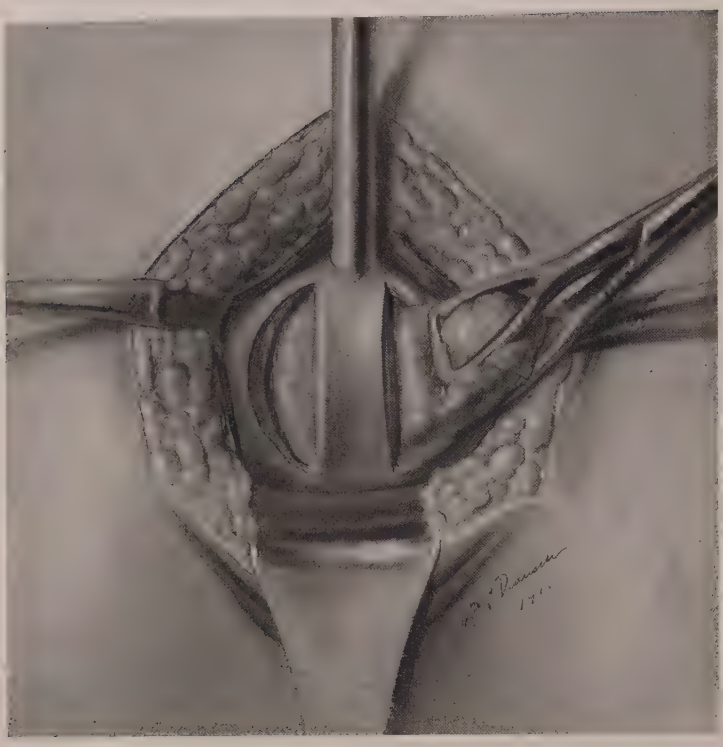


FIG. 806.—Young's perineal prostatectomy: Enucleation of lateral lobes through two parallel capsular incisions.

FIG. 807.—Young's perineal prostatectomy: After removal of both lateral lobes the median is drawn down with tractor and pushed into left lateral cavity with index-finger in opposite cavity previous to enucleation of middle lobe.

erated upon by this technic, in which the lateral lobes are removed separately from each side, and the median lobe through one of the lateral cavities (Fig. 807).

These lateral incisions are about 2 cm. apart and parallel with the urethra (preferably curving outward to divide the anterior capsule of the prostate on each side—this gives more room). A blunt dissector is then inserted and the right lateral adenomatous capsulated mass separated from the surrounding normal prostatic tissue. The left hypertrophied mass is similarly freed before the deeper attachments are attached on either side. The index-finger is then inserted on the left side and the left hypertrophied lobe enucleated, breaking it away at its attachment to the middle lobe, and following it within the vesical sphincter if it projects intravesically. With the left index-finger the right lobe is then enucleated,

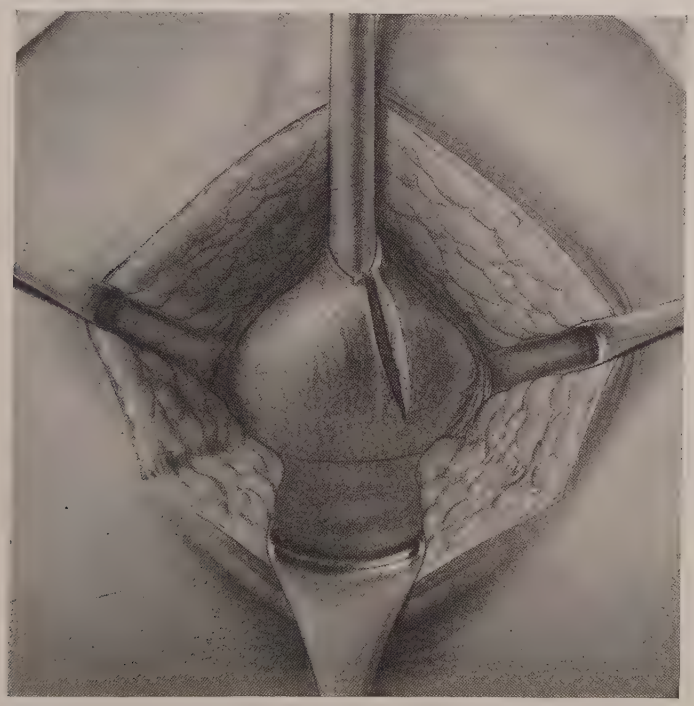


Fig. 808.—Young's perineal prostatectomy: Single lateral capsular incision sometimes employed; being slightly oblique, the ejaculatory ducts are avoided.

but *the median is brought away with it if possible.* This is done by turning one blade of the tractor down so as to engage the middle lobe and then by traction and rotation, assisted by a finger in the opposite cavity, the middle lobe is made to appear in the lateral cavity where it is easily enucleated (Fig. 807).

More recently, *a single incision*—either oblique, or slightly to one side of the median line (Fig. 808), so as to avoid the verumontanum and ducts—has been tried. Through either of these it was found possible to enucleate the hypertrophied lobes in one piece but with some difficulty, owing to the smallness of the capsular wound.

Through *the inverted* V capsular incision, the operation is done as follows: The prostate being drawn well up into the wound, an incision is made on one side, beginning at the posterior angle of the urethrotomy wound at the

apex of the prostate, and extending obliquely backward toward the base of the prostate, for a distance from 2 to 4 cm., according to the enlargement of the prostate (Fig. 809). A similar incision is made on the opposite side. These are carried quickly through the substance of the posterior lobe until the urethra is reached on each side. This liberates a triangular flap of prostate and posterior urethra, in the center of which the verumontanum can be easily seen (Fig. 809, *a*).

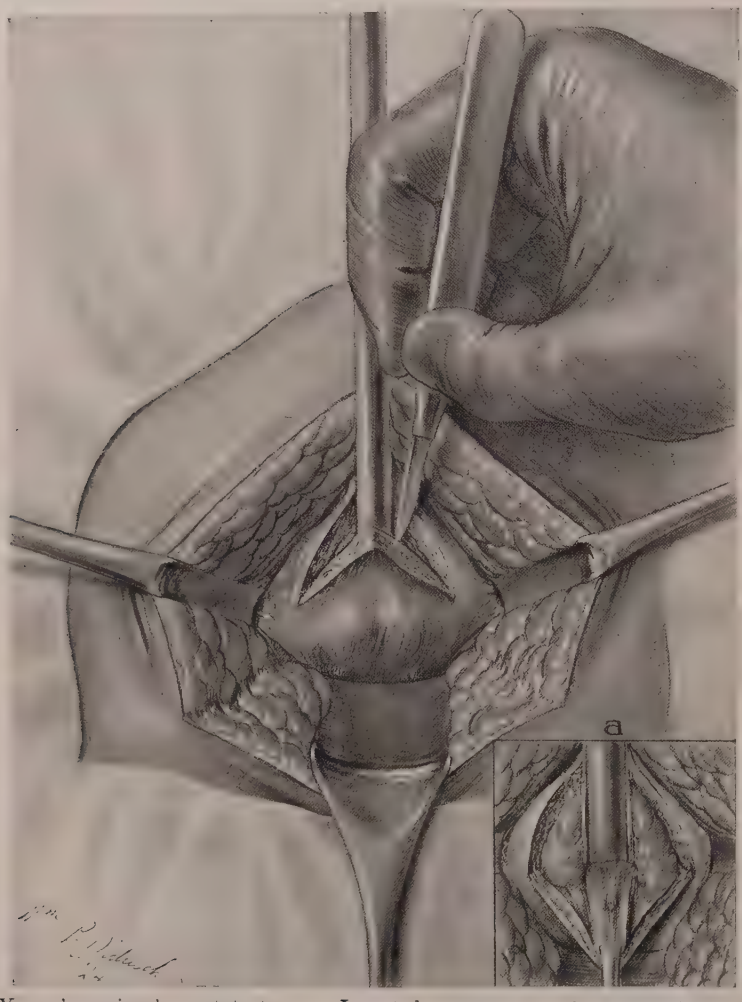


FIG. 809.—Young's perineal prostatectomy: Inverted V capsular and urethral incision to expose lateral lobes of prostate and turn back floor of urethra and verumontanum.

The next step is to divide the lateral wall of the prostatic urethra longitudinally on each side until the region of the middle lobe is reached.

Enucleation of the Hypertrophied Lobes.—Making *traction upon the prostate*, one is able to see by careful inspection of the incision, on each side, a layer of prostatic tissue surrounding the encapsulated hypertrophied lobe. *By inserting a blunt dissector* at this point (Fig. 810), one can quickly separate the two and begin the enucleation of the lobe. By to-and-fro motion this is carried quickly backward until considerable depth is reached and the lobe freed from its attachments ex-

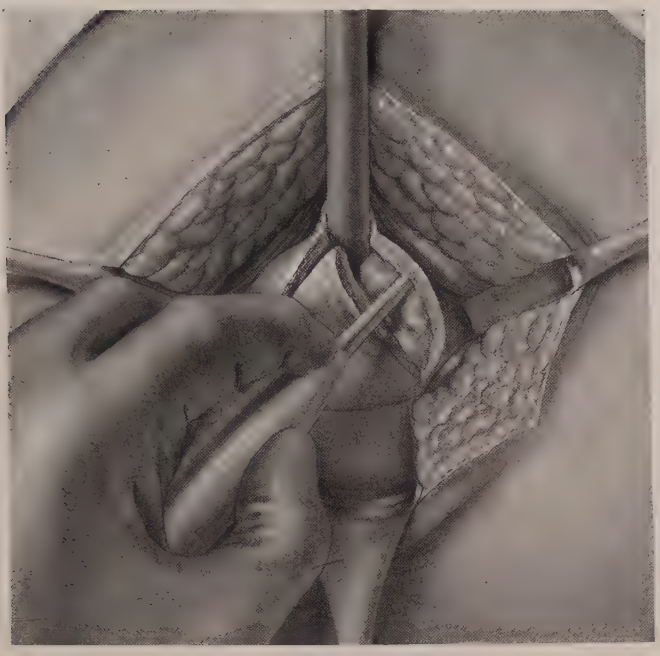


FIG. 810.—Young's perineal prostatectomy: Beginning of enucleation of left lateral lobe after making inverted V capsular incision.

FIG. 811.—Young's perineal prostatectomy: Enucleation of lateral lobes completed anteriorly, but still attached to median lobe beneath tractor.

ternally, in front, posteriorly, and from the floor of the urethra. Care should be taken not to injure the ejaculatory ducts. The same procedure is carried out on the opposite side.

The *index-finger of the right hand is then introduced* into the cavity between the prostate and the adenoma on the left side (Fig. 811), and carried by blunt dissection downward, while traction is made with the left hand upon the shaft of the instrument. As the adhesions are broken down and the hypertrophied lobe freed, the operator will soon feel, through the wall of the bladder, the blade of the prostatic tractor. If the lobe projects into the bladder, it may be drawn out by traction through the sphincter into the lateral cavity and its deeper attachments partly freed.

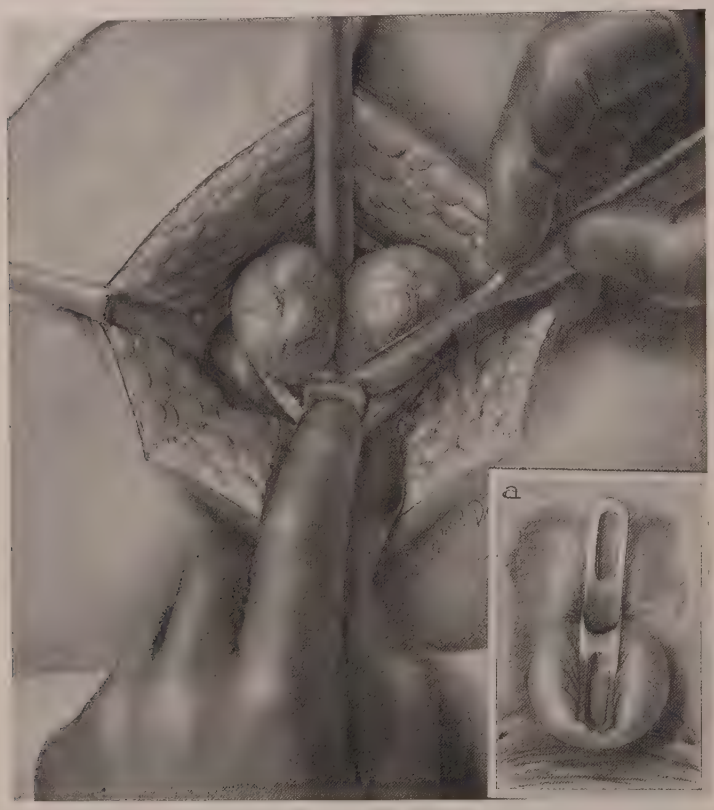


FIG. 812.—Young's perineal prostatectomy: Lateral lobes freed; finger of left hand is pushing the floor of urethra and ejaculatory ducts backward, while knife divides mucous membrane covering lower anterior surface of middle lobe, which is continuous with the two lateral lobes. *a*, View within bladder to show the position of tractor blades by which the middle lobe is drawn down, lateral lobes having already been enucleated partly.

Changing hands, the operator then attacks the right lobe of the prostate with *the finger of the left hand*, at the same time making traction upon the instrument with the right hand. The right lobe is then freed from the vesical mucosa, the only attachment being with the mucous membrane as it passes from the bladder into the urethra where it is attached to the inner surface of the lateral lobes.

The median lobe now remains to be freed. To accomplish this, one blade of the tractor is turned downward (Fig. 812, *a*), and traction made by an assistant.

The index-finger of the left hand is then inserted along the posterior urethra until the tip rests against the anterior surface of the middle lobe. Backward pressure is then made, thus pushing the verumontanum and ejaculatory ducts out of the way (Fig. 812), while the blade of a scalpel is inserted along the dorsum of the finger until the middle lobe is reached, when the mucous membrane covering it is divided transversely with the knife near its posterior surface. One is careful to keep close to the hypertrophied middle lobe and not to injure the ejaculatory ducts, which are carried backward in this blunt dissection.

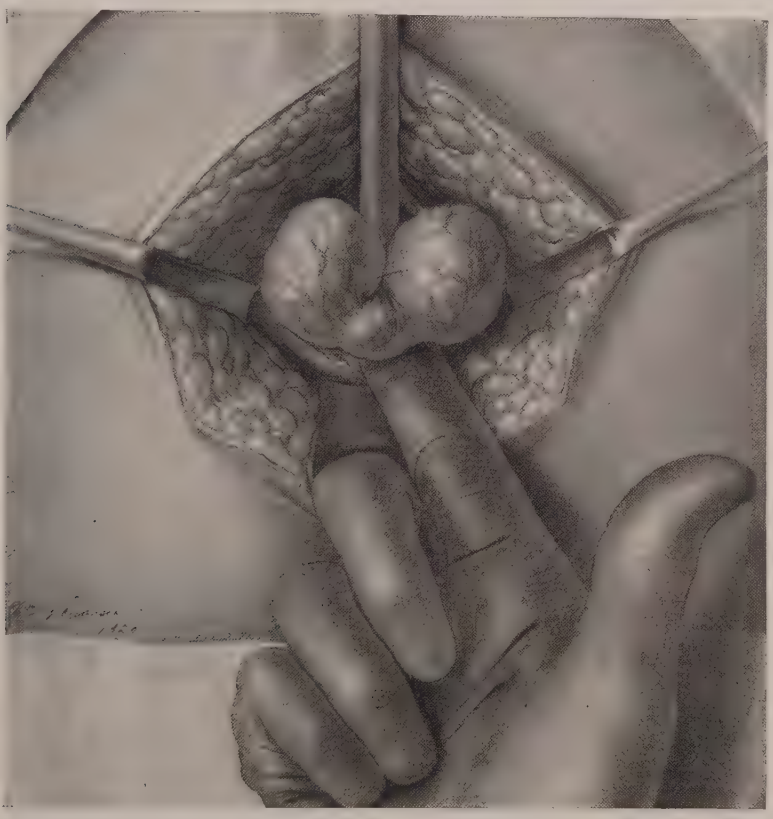


FIG. 813.—Young's perineal prostatectomy: Middle lobe attached to lateral lobes is being separated from sphincter and vesical mucosa. Floor of urethra, verumontanum, and ejaculatory ducts lie beneath finger.

The object of these divisions of the mucous membrane covering the lateral and middle lobes is to enable the operator to enucleate the hypertrophied prostate in one piece from in front of the ejaculatory ducts. (The same occurs when the prostatic lobes are enucleated intra-urethrally through suprapubic prostatectomy, only much more mucous membrane is then removed.) Sweeping the finger from side to side and continuing the traction upon the middle lobe, *the whole adenomatous prostate is drawn outward* and the median and lateral lobes freed, gradually, from the cone of mucous membrane which forms their urethral covering.

It may be well, here, to grasp the lobes with lobe forceps or Allis clamps in order to facilitate their withdrawal while the mucous membrane is slowly stripped from their inner surfaces from behind. In this final separation a long tube of mucous

membrane is freed. Inspection of each side of this will frequently show an artery (inferior vesical) which may be clamped and ligated. If the cone of the urethral mucosa is quite long, it is desirable to clamp the mucous membrane and cut it off with scissors on each side. The hypertrophied lobes, completely freed from attachments and mucous membrane, are then removed, generally in one piece. Sometimes a subtrigonal lobule is present. It should be looked for and removed along with the rest of the median lobe (Fig. 814). Specimens removed as above described are shown in Figs. 815–819.

The conditions present at this moment are as follows: The floor of the urethra, verumontanum, and ejaculatory ducts have been pushed backward into the bottom

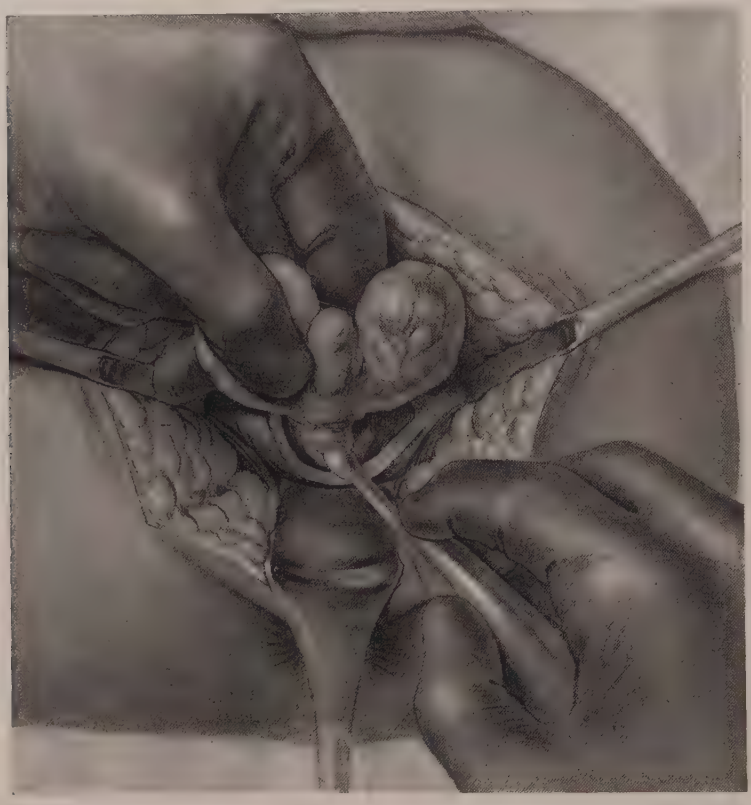


Fig. 814.—Young's perineal prostatectomy: The tractor has been removed and the index-finger of the left hand introduced through the vesical orifice into the bladder to investigate the median portion. A subtrigonal lobule has been discovered and is being separated from the sphincter by a curette.

of the wound. In the depths, on each side, and in the median line are cavities from which the lateral and median portions of the prostate have been removed (Fig. 820). The sphincter is usually dilated and within it lies a tube of mucous membrane which has been grasped on each side, in front, and behind with Allis clamps, by which it is held forward.

Examination of the Bladder.—After removal of the lateral and median lobes the index-finger of the right hand is then inserted through the vesical sphincter for careful palpation. It is well to search on each side to see whether there be any remaining lobule. Another finger within the prostatic cavity may assist in a bidigital inspection. The condition of the *vesical sphincter* is noted; if extremely tight, it

FIG. 815.—Perineal prostatectomy: A, Anterior view of lateral and median lobes removed in one piece through an inverted V capsular and urethral incision. B, Side view of right and median lobes of specimen. Note the constriction of median lobe by sphincter and small subtrigonal posteriorly projecting lobule. C, Vesical aspect of prostate showing small intravesical median and very large extravesical lateral lobes. If this had been removed suprapubically the sphincter would have been destroyed. B. U. I. 9198.

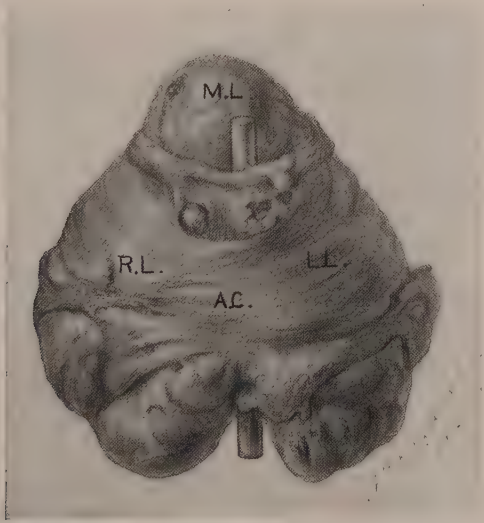


FIG. 816.—Perineal prostatectomy. Anterior view of hypertrophied prostatic lobes removed *en bloc* with anterior commissure and portion of prostatic capsule. Glass tube shows site of urethra. B. U. I. 10,252.

should be dilated; if very fibrous, it may be divided posteriorly or a piece removed from it with a "punch." The operator should be careful to see that there is no

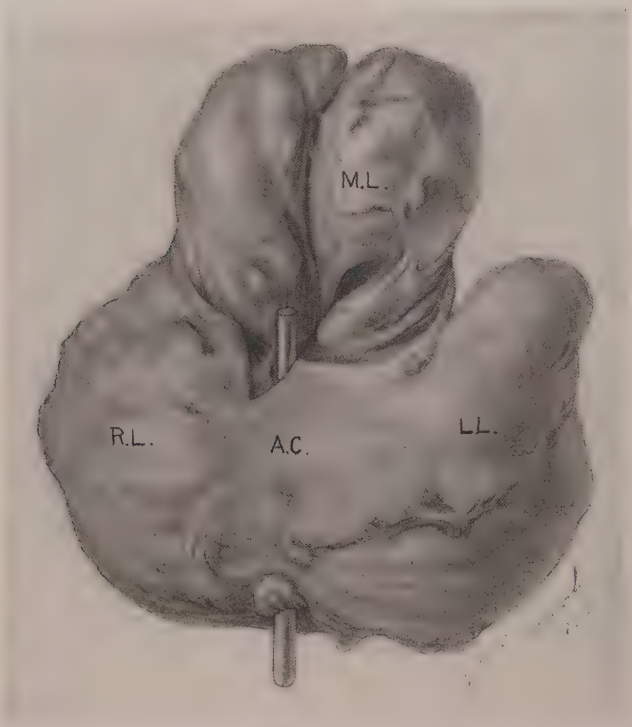


FIG. 817.—Anterior view of very large prostate removed in one piece through perineum. The anterior commissure, *A.C.*, has been removed with the right and left lateral lobes and the middle lobe, *M.L.* B. U. I. 9078.

FIG. 818.—Perineal prostatectomy by the bilateral capsular technic. The left lateral lobe has been removed in one piece. Note where it was broken off from the median lobe which was removed with the right lateral in one piece. The urethra, verumontanum, and ejaculatory ducts in this case were preserved. B. U. I. 13,433.

subtrigonal prostatic and no anterior lobule which has escaped detection (Fig. 814). The lower portion of the bladder may be palpated with the finger.

Removal of Calculi.—A stone scoop is then introduced to be sure that there is

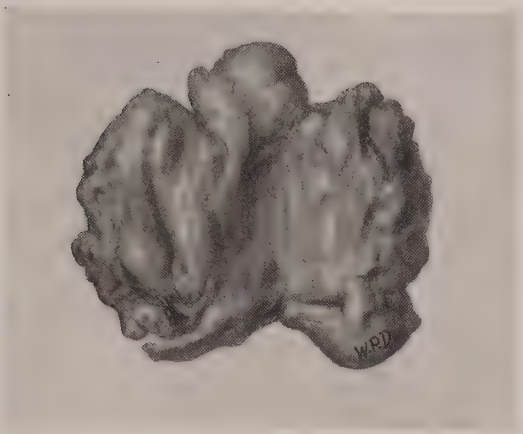


FIG. 819.—Small fibroid prostate removed in one piece by perineal prostatectomy through an inverted V capsular incision. Weight, 19 grams. B. U. I. 9180.

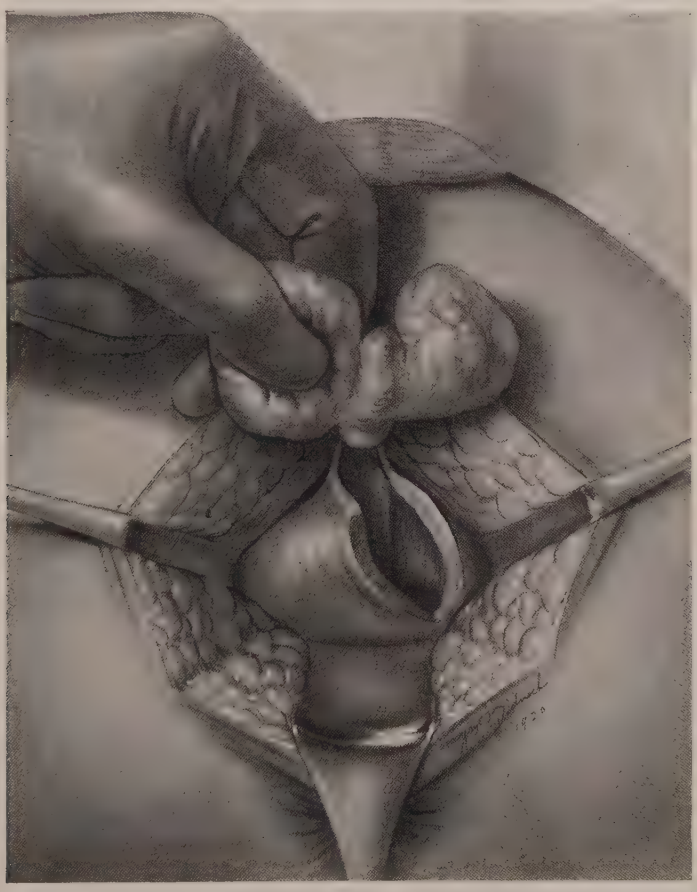


FIG. 820.—Young's perineal prostatectomy: Condition present after removal of lateral, median, and subtrigonal lobule. Normal subcapsular tissue remains. Ejaculatory ducts preserved; roof and floor of urethra intact; cavity on each side and in region of middle lobe. Vesical sphincter intact. Unilateral oblique capsular incision.

no calculus in the depths of the bladder which had not been observed cystoscopically. If one is found, it is promptly removed through the wound (Fig. 821). If

very large, it may be necessary to dilate considerably or even to divide the vesical sphincter. In the latter case, it may be desirable to take a few stitches in the divided sphincter. We have frequently done this, but do not believe it essential. We have removed calculi through the perineum $2\frac{1}{2}$ inches (6 cm.) in diameter without much difficulty and in one instance detected and removed a calculus which projected from the orifice of the ureter.

Drainage and Packing.—For many years a large rubber drainage-tube (notched, fenestrated, and the end cut obliquely) was introduced through the prostatic urethra, which is held apart by the retaining clamps. It should pass about an inch into the bladder and be held in position while the operator inserts one or more strips of antiseptic gauze within the sphincter so as to prevent regurgitation of blood into the bladder and to assist in the hemostasis of the deep wound. The

FIG. 821.—Young's perineal prostatectomy: Removal of stone from bladder after enucleation of prostatic lobes.

lateral and median cavities are then packed solidly with antiseptic gauze until completely filled. A small catheter to be used for subsequent injection of oil into the mass of gauze packing is inserted (Fig. 822).

The operator then makes careful observations to see that no serious hemorrhage continues. The bladder is washed out with a large piston syringe. The fluid should finally come away almost clear or only slightly tinged with blood, and the wound should be free from active hemorrhage. If it continues to ooze, additional packing should be inserted until by pressure the bleeding ceases. Good hemostasis is a most important feature after prostatectomy regardless of the route by which the operation is performed. The deeper portions of the prostatic wound contain numerous large vessels which may bleed profusely and the operator should be sure that these have been controlled by pressure before the patient is returned to the ward. For several years we have experimented with various designs of in-

flatable balloon drainage apparatus. Recently, a former resident, Dr. E. G. Davis, has shown that a modified Pilcher bag, which he has designed, is entirely satisfactory, and we now use this very simple apparatus. The Davis bag can usually be introduced into the bladder with a curved stone forceps. Sometimes it may be more easily introduced by first dilating the vesical sphincter with his special four-pronged dilator. The tube for drainage and the traction tape emerge from the perineal wound. With these no gauze pack is used, and we are generally able to approximate partly the inverted V capsular incision on one side. As soon as the Davis bag is in place it should be blown up with water (we use a bulb syringe and insert some 50 or 60 c.c.). Traction is then made upon the tape, so as to draw

Fig. 822.—Young's perineal prostatectomy: Large tube has been inserted into bladder, a small tube into the cavity for the injection of oil to facilitate removal of gauze which has been introduced into lateral cavities to arrest hemorrhage.

the vesical neck outward and stop hemorrhage, and the bladder is washed clean of clots through the central drainage-tube with a large syringe.

Approximation of Levator Muscles.—With a single large plain catgut stitch these muscles are drawn together to their normal position in front of the rectum. This is important, as it prevents pressure of the gauze pack upon the rectum and resultant rectal breakdown.

Closure of Skin.—The tubes (and gauze, if used) are brought through one angle of the wound while the skin is approximated on the other side and in front, as shown in Fig. 823. We usually employ a mattress-suture of catgut as a stay-suture at the apex of the skin flap, and apply clips upon the skin elsewhere. The tube is fastened in place by tying the loose ends of the ligature around it. This also includes the small catheter, which is usually inserted into the depths of the gauze pack for subsequent injection of oil, which is intended to soften the mass and facili-

tate its removal. If the Davis bag is used, a clamp is placed on the traction tape, a pad of gauze being inserted between the clamp and the wound.

Variations and Technical Details.—The operation as above described is often modified. When the patient has extremely *high blood-pressure*, epidural anesthesia is usually substituted for gas as an anesthetic and great care is taken in changing the patient from the horizontal to the exaggerated dorsal prostatectomy position so as not to bring too sudden a strain and thus increase the blood-pressure greatly. Many of these cases have been done under ether, but, even though great care is taken, we have had a number of cases in which the blood-pressure at the beginning varied from 210 to 240 and subsequently rose to 260, 270, 280, 290, and even 300. The high blood-pressure often continues thus until the latter part of the operation, when there is not infrequently a rapid fall. In 1 case in which it reached 300 in the early stages of the operation, it fell to 150 when the patient was taken from the table, but the patient made an excellent recovery. In *organic heart disease* ether is to be preferred to other anesthetics unless pulmonary or renal complications contraindicate its use. The use of spinal anesthesia has many advocates. It is, undoubtedly, applicable to cases with renal or pulmonary lesions. Its use is generally associated with a marked fall in the blood-pressure—sometimes alarming—and occasionally the patient appears much shocked after operation. We have had one death with spinal anesthesia and, therefore, think the method less safe than general anesthesia. *Caudal injections* of procain give a splendid anesthesia of the perineal region by using a 3 per cent. solution of procain and not over 20 c.c. A fall in the blood-pressure can usually be avoided by the use of 5 to 10 minims of a 1:1000 adrenalin solution intramuscularly.

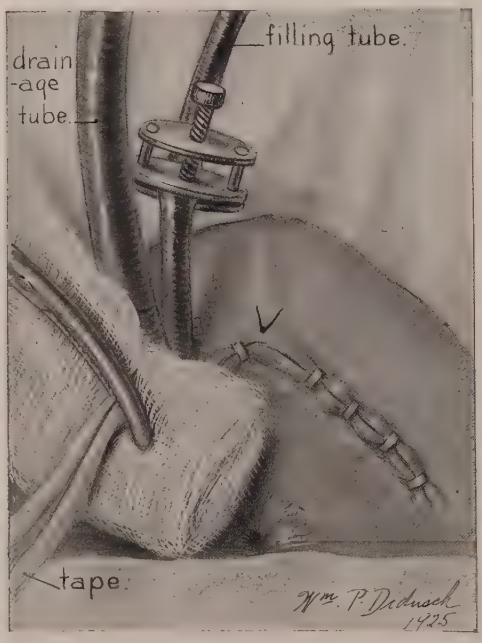


Fig. 823.—Young's perineal prostatectomy: Davis perineal hemostatic bag and drain in place. Filling tube closed, traction made with tapes held by Kelly clamp against pad of gauze.

Where the patient is short, thick-necked, or very fat the perineal prostatectomy position may be associated with difficult breathing. It may be necessary to depress the head, release the pressure of the shoulder-pieces, and let the patient slide back to improve respiration. Epidural (caudal) anesthesia is undoubtedly the method of choice.

In introducing the *urethral sound* with the patient in the urethrotomy position, one may find the urethra so acutely flexed that it is difficult to enter the membranous urethra from the capacious bulbous urethra. By taking great care to hug the roof of the bulbous urethra, and with the assistance of a finger pressing against the perineum, the beak of the instrument can usually be guided into the deep urethra

without difficulty. In some cases we have had to lower the thighs in order to introduce the sound.

During the operation the attendant who is holding the sound in position within the urethra may carelessly allow it to slip out into the bulbous urethra. On several occasions when this has occurred the attendant attempted to push it back into its previous position through the membranous urethra and (not doing so) caused a false passage. In one or two instances this was not detected at once by the operator and great difficulty was encountered in finding the membranous urethra which lay to one side.

Such difficulties can be avoided by carefully instructing the attendant to hold the sound in exactly the position in which it is given him.

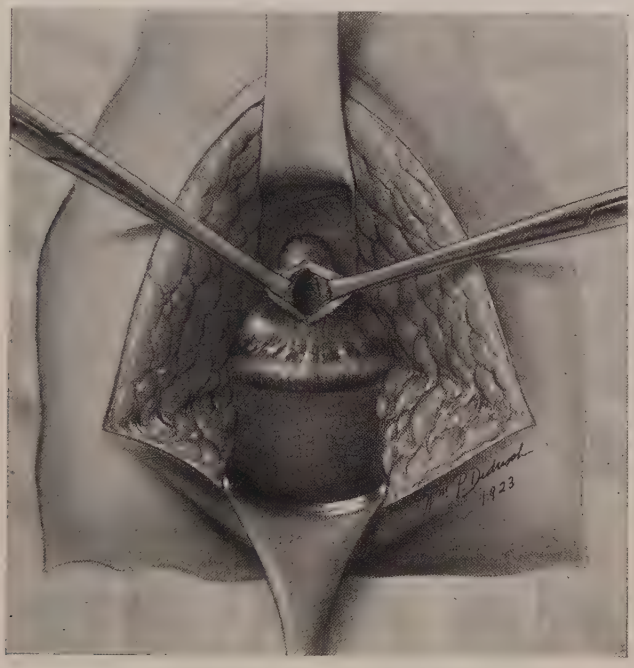


Fig. 824.—Prostatectomy through perineum without freeing posterior surface of prostate when very adherent to rectum. Urethra opened at apex.

In making blunt dissection on each side of the *central tendon* we have occasionally gone too far forward and have come out in the triangular space in front of the transversus perinei muscle on each side of the bulb in front of the triangular ligament. This can be avoided if the operator will be certain to look for or feel the transversus perinei muscle in front of the line of blunt dissection. When the operator has through error made the blunt dissection in front of the transversus perinei muscle on each side of the bulb he should at once back out and open up the proper space behind the muscle. This is not difficult, and unless it is done considerable trouble will be experienced in reaching the prostate, as it will be necessary to penetrate the triangular ligament. In so doing the muscular structures in the region of the external sphincter may be seriously injured and incontinence result. With care and attention to the muscular landmarks, the operator who knows the anatomy of the perineum should have no difficulty in opening up the space on each side of the central tendon behind the transversus perinei muscles.

Having inserted the bifid retractor, one should be careful in the division of the central tendon not to injure the bulb. If this occurs, bleeding may be profuse and should be controlled by transfixion stitches through the capsule and surrounding muscle, but not penetrating the bulb. If by chance the rectum is injured at this stage of the operation, it should be closed promptly with two or three layers of sutures and suprapubic prostatectomy carried out. One should be sure, therefore, to examine the rectum carefully before opening the urethra.

FIG. 825.—Perineal prostatectomy where prostate is extremely adherent to rectum. The prostate is incised, only the apex being freed from rectum.

In the *exposure of the membranous urethra*, one can often detect Cowper's glands on each side and immediately beneath them the sphincteric musculature. One must be careful to push these structures forward with a scalpel handle and then to retract them with the bifid bulb retractor which partly encircles the urethra. In this way the sphincter is drawn forward, entirely out of the way and danger of incontinence avoided with comparative certainty. Traction should not be too forceful lest a traumatism occur.

The operator should learn early to recognize the *anterior layer of Denonvilliers' fascia* which covers the prostate. After dividing the posterior layer and pushing it back for a short distance, the anterior layer will be recognized by its pearly white,

almost shiny appearance. When the posterior surface of the prostate is covered with longitudinal fibers, one may be sure that the proper depth has not yet been

FIG. 826.—Enucleation of prostate *en bloc* with anterior commissure intact: *A. C.*, Anterior commissure.

obtained and continue by further transverse dissection until the space between the two layers of Denonvilliers' fascia is reached.

FIG. 827.—Perineal prostatectomy specimen, consisting of large lateral, small posterior median (*Post. L.*), large intravesically projecting anterior lobe (*Ant. L.*), removed in one piece with pathologic capsule. In practice it is best not to remove so much of the pathologic capsule.

The prostate is frequently held by *adhesions* so that it is impossible to draw it toward the perineum, and occasionally the rectum is so firmly fixed to the posterior surface of the prostate that it is advisable, after exposing the apex and introducing

the prostatic tractor, to open the prostate with an inverted V incision (Figs. 824, 825), and begin the enucleation of the hypertrophied lobes without exposing the

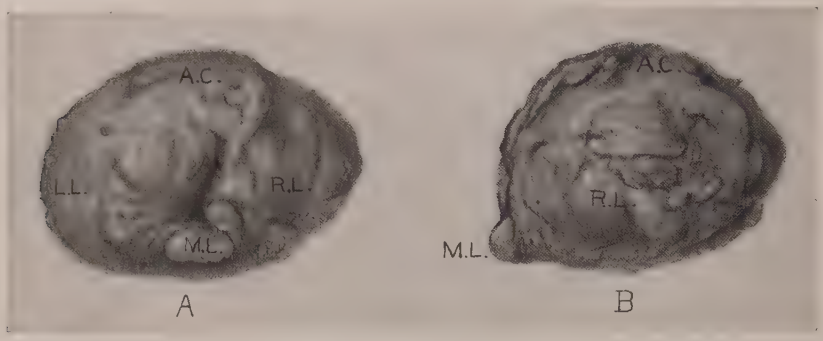


FIG. 828.—Specimen removed by perineal prostatectomy, *en bloc*, with anterior commissure, *A.C.*, which is continuous with the right lateral lobe, *R.L.*, and the left lateral lobe, *L.L.*, on each side. The median lobe, *M.L.*, is very small. A, Vesical aspect. B, Left lateral aspect.

posterior surface of the prostate. As a matter of fact, it is not at all necessary to strip the rectum from the posterior surface of more than the apex of the prostate,

FIG. 829.—Perineal prostatectomy specimen. Large median and lateral lobes enucleated with pathologic capsule and a portion of the membranous urethra (an unnecessarily radical operation). Stricture and incontinence resulted from excessive removal of urethra shown. In this case a silver catheter had been used; specimen shows a false passage through the middle lobe produced by it. B. U. I. 10,983.

as it is quite easy to enucleate the adenoma through an inverted V apical incision.

When it is shown by previous cystoscopy that *the anterior commissure* contains

hypertrophied tissue or an intravesically projecting anterior lobe, one may remove this with the lateral and median lobes in one piece (Fig. 826). As shown in Figs. 827 and 828, the specimen not infrequently shows circular fibers which enclose the hypertrophied tissue of the anterior commissure which is removed in one piece with the lateral lobes. Other specimens of different types are shown in Figs. 829 and 830.

Sometimes the enucleation of *the lateral lobes* is facilitated by simply breaking through the roof of the urethra on each side at the anterior limit of the lateral lobe and proceeding outward. This gives the proper line of cleavage and may often be adopted with success. This is the technic which is employed in the intra-urethral enucleation through the suprapubic wound, and while more mucous membrane is thus removed with the lateral lobes, the ultimate healing seems to be just as satisfactory.

In the region of *the middle lobe* one not infrequently finds a separate lobule deep down beneath the mucous membrane of the anterior part of the trigone. With care the deeper masses can usually be enucleated in one piece with the rest of the prostate (Fig. 814), but occasionally investigation shows an isolated lobule sometimes 1 or 2 cm. in size which has been left behind after apparently complete removal of the median and lateral lobes. By careful palpation with one finger in the bladder and another outside, this can be detected. In drawing up some of these deep lobes, and sometimes during the removal of the principal lateral and median lobes, one may use our "spoon" tractor (Fig. 831), which when introduced into the bladder will encompass the intravesical lobe and more certainly draw it up to the operator.

Fig. 830.—Specimen removed by perineal prostatectomy, anterior view, showing commissure connecting lateral lobes.

Occasionally *a lobe may become detached* and slip back into the bladder. Careful inspection of the specimen should therefore be made to be sure that nothing is missing, and if so, it should be sought first within the prostatic capsule and then within the bladder with stone forceps. In one instance, a lobe $1\frac{1}{2}$ inch in diameter escaped us and had to be removed later. In another case a lobe which projected far back behind the bladder in the region of the seminal vesicles was not detected until it descended several days later and caused obstruction in the prostatic urethra.

Where the prostate is huge, it may be difficult to remove it in one piece. In such cases it is sometimes better to separate the specimen and remove the prostate in two or three separate lobes. The *advantage of removing the prostate in one piece* is the greater certainty of complete enucleation. The disadvantages are that it un-

questionably causes more mutilation of the urethra and the inverted V capsular wound heals more slowly than the simple median urethrotomy and the bicapsular incisions to remove the lateral lobes. A very careful study of our records as to convalescence shows conclusively that, *of the various capsular incisions, the bilateral has been followed by the most rapid closure of the wound.* In many cases it was possible with the bilateral technic to preserve the urethra absolutely intact, even the median lobe being enucleated through one of the lateral cavities without removing or even tearing the mucous membrane. In most cases the urethra was torn on one or both sides, but very rarely was any or much removed. A study of results shows that the median urethrotomy wound closed more rapidly than that left after the inverted V capsular and urethral incision. By this technic also the re-

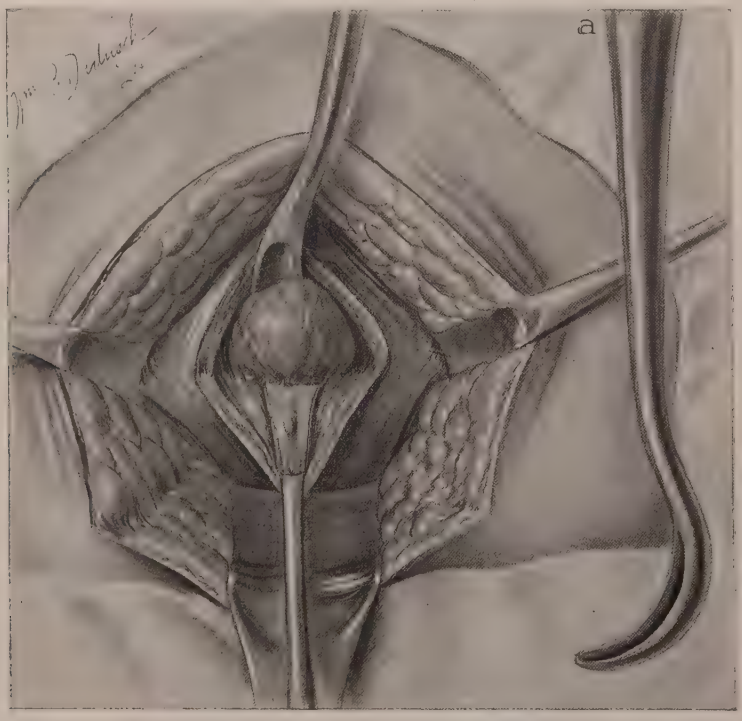


FIG. 831.—Perineal prostatectomy: Enucleation of a pedunculated intravesical middle lobe by means of a spoon tractor (*a*), which is used to draw it down into the cavity left after the removal of the two lateral lobes. The verumontanum and floor of the urethra are seen.

sults, as to *preservation of sexual powers,* appear to be slightly better, but *the superiority of the inverted* V *capsular technic* in the enucleation is because by no other technic, perineal or suprapubic, can so perfect an enucleation of the entire adenomatous mass be effected, and the traumatism to adjacent normal structures is far less than that produced by attempting to carry out the same procedure through the bladder, in which procedure it is necessary to so greatly dilate and probably permanently destroy the function of the internal sphincter. Subtrigonal and retrovesical lobules are also much more easily and completely removed by the inverted V capsular incision, and recurrences are more surely prevented. But, *in the last analysis, we now prefer the bilateral capsular incisions,* the left lateral lobe being enucleated separately and the right and median together (or separately).

The Davis bag is then introduced into the bladder through the right lateral cavity and through the sphincter.

In the removal of stones great care should be taken that all calculi detected by cystoscopy or *x*-ray are accounted for, and if cellules or diverticula are present to search carefully to see that no stones are left behind. With the finger in the bladder its posterior surface and the interior of some diverticula can be digitally examined and stones in the depths detected and removed.

In placing the gauze packs or rubber bag within the vesical sphincter, care should be taken not to carry the mucous membrane into the bladder and thus evert it. We have seen 1 case in which a long flap or hood of mucous membrane, which had been stripped off a huge middle lobe, was thus pushed far into the bladder, and from its tip, which was not reached by the gauze packing, a large vessel continued to bleed, with fatal result. This accident can be prevented by not only making traction upon the clamps which hold the urethral mucous membrane but also by inserting the finger or curved scissors within the sphincter and carefully introducing the gauze upon this.

The prevention of hemorrhage is most important and even if ten or twelve long strips are required, the operator should persist until he is sure that he will not have to introduce additional packing into the wound after the return of the patient to the ward. We have not always done this and have lived to regret it. The new Davis perineal drainage-tube and hemostatic bag eliminates all trouble from hemorrhage and during the last 100 cases we have used no gauze packing at all.

In closing these comments on complications, it is only fair to state that usually no difficulty is experienced in carrying out the operation quickly and effectively, that three or four strips of gauze completely arrest the hemorrhage in most cases, that prompt healing with perfect urinary control may be expected; and in fully 80 per cent. of the cases sexual powers are as good as before operation and in a few cases better. As one patient wrote, "The only difference is that sexual intercourse takes about five minutes longer, but I don't begrudge a minute of the time."

The great advantage of the operation is that it is performed under the complete visual control of the operator; that hemorrhage encountered is stopped; the enucleation is certain in its completeness; the verumontanum, ejaculatory ducts, external and internal sphincters are protected; dependent drainage for urinary and inflammatory secretions is obtained; and the lowest possible mortality rate is secured.

Postoperative Treatment.—Before leaving the operating room the operator, or his first assistant, should take care to see that hemorrhage has been stopped and that the patient is not severely shocked. If red blood continues to emerge from the tube or the dressings, the bladder should be washed out and, if the bleeding continues, the wound should be packed anew, or additional packing introduced.

With the use of the Davis drainage bag all such difficulties are now practically eliminated as it is possible, either by making additional traction or by introducing more fluid into the bag, to stop all intravesical bleeding and to have practically clear fluid emerging from the tube. This bag also stops all extravesical bleeding, and in 100 cases we have not found it necessary to pack the extravesical wound, or in fact, to use any packing at all.

If the patient is definitely shocked, he is not removed from the operating floor, but is given supportive treatment; viz., elevation of legs; caffein sodium benzoate

hypodermically, 4 grains; morphin, $\frac{1}{4}$ grain; saline hypodermoclysis, 1500 c.c.; hot-water bottles at various places.

On return to the ward the patient is placed on a special perineal mattress. This mattress has a hole about 4 inches in diameter at a point corresponding to the position occupied by the perineum. Over this is placed a large rubber pad with a pneumatic ring at its periphery. In the center is a large rubber tube (diameter 3 inches) which passes through the hole in the mattress and the fenestrations of the wire bed-spring. Beneath it is a basin on the floor containing a half-gallon bottle into which a rubber tube conducts the drainage from the wound. A glass tubing bent in the form of a complete loop is inserted in the course of the drainage-tube and has a twofold advantage; first, that the character of the fluid coming from the bladder can be seen by looking at this glass loop beneath the bed, and, second, that it prevents the passage of air up the tube, in which a column of water forms and acts as a siphon.

As soon as the patient is settled in bed and the drainage apparatus connected up, hot-water bottles are placed around him and he is given salt solution beneath the breast (subpectoral). A simple method of keeping the salt solution warm during its slow entrance into the tissues is to place a hot-water bag on each side of the glass receptacle hanging on a pole near the patient's bed. Fifteen hundred cubic centimeters of salt solution are usually given to each patient and in many cases this amount is absorbed entirely by one breast. In other cases, where the absorption is poor, it is advisable, after 700 or 800 c.c. have been introduced, to withdraw the needle and continue the hypodermoclysis on the opposite side. In all cases which have had general anesthesia this saline infusion is given as a routine.

In cases operated on under epidural caudal anesthesia nausea is almost never present and the patient is given water to drink immediately on return to the ward. He is encouraged to drink water in as large amount as possible to replace fluids lost at operation and to incite renal activity. If such cases are nauseated, they are given submammary infusions.

Immediately after the return to the ward the interne on ward duty is instructed to observe the drainage and to watch it frequently thereafter. If it does not rapidly clear, and particularly if the pulse is increased in rapidity and decreased in volume, he is instructed to notify the resident. The operator is notified if the hemorrhage is alarming. The bladder should be palpated and, if found distended, a large suction syringe should be used to withdraw accumulated clots from the bladder. This, alone, is usually sufficient to stop the bleeding, the contracted bladder having a distinct hemostatic effect. Blood is obtained for grouping and matching should transfusion be required.

The problem for the operator is to decide whether repacking should be done. If the continuation of the hemorrhage and the mounting of the pulse makes this seem advisable, the operator may either introduce additional packs with the assistance of a finger inserted into the wound and directing the gauze along the side of the tube into the bladder, or by the use of Gerota's packing tube. This is occasionally successful, but in 1 case in which we introduced a large amount of gauze in that way the hemorrhage did not cease and at autopsy we found that the packing had gone, not into the bladder, but anterior to the bladder, where it formed a large retropubic mass. In this case a huge prostate had been removed, there was a large intravesical flap of mucosa which had covered the middle lobe, which pro-

jected far up into the bladder and from the tip of which an artery continued to bleed, even after a large amount of gauze had been introduced into the wound.

A better plan is, therefore, to remove all packing, to insert the finger into the vesical orifice, see that the mucous membrane is everted and all flaps drawn into the prostatic cavity, where they are caught with Allis clamps, and the orifice held open. A large drainage-tube is inserted and surrounded by gauze packs, and the lateral cavities then packed with gauze until the hemorrhage is controlled. It is best not to wait too long before carrying out such repacking, but the operator must realize that fairly considerable bleeding may occur without danger and that in almost all cases it ceases spontaneously. During or after such procedures, vigorous supportive treatment is indicated; viz., caffein, morphin, hot-water bottles, elevation of foot of bed and legs and thighs of patient, but principally, transfusion of blood from a matched donor. Such transfusions should be given fairly early, before the patient is *in extremis*, because it not only has the effect of improving the coagulating power of the patient's blood, but also combats the shock and puts the patient in a much better condition to resist infection during his convalescence. In very weak or very old patients early blood transfusion may be very desirable, even if there has been little or no hemorrhage at operation, but one must, of course, be absolutely sure of the grouping and matching. One must realize that the reaction following blood transfusion is in itself sometimes quite alarming.

Happily, since adopting the Davis modification of the Hagner bag for drainage and hemostasis in our perineal prostatectomy cases, practically all difficulty with hemorrhage at operation and immediately afterward has been done away with, and the elaborate instructions which have been given above are fortunately not necessary.

Removal of Drainage and Packing.—When gauze has been used, it is generally advisable to begin its removal within forty-eight hours. It should be first softened by the injection of oil, preferably through a small tube which has been left in the wound at operation. But oil may also be introduced through the large vesical rubber drain into the bladder, through the urethra and into the perineal wound. The gauze is twisted, so as to make it smaller and free it from adhesions, and then pulled out slowly. It is usually desirable to remove it in two or three séances. The patient is usually given morphin, grain $\frac{1}{4}$, and despite this, not infrequently suffers considerable pain. Occasionally fresh hemorrhage occurs. The rubber drainage-tube is allowed to remain in place several hours longer, until we are sure that hemorrhage has not occurred.

Here again, the use of the Davis drainage apparatus has greatly facilitated this part of the convalescence. Where this apparatus is used, the procedure followed is this: About six hours after the operation, if the drainage is clear, the traction tapes are released and the bag, thus freed, travels back into the bladder, where it is allowed to stay, still distended, for a few hours. Then, no fresh hemorrhage having occurred, a portion of the water distending it is allowed to escape, and on the following morning the bag is completely emptied. A little later the entire apparatus is withdrawn from the wound. In none of the cases in which we have used this apparatus has it been necessary to repack with gauze, nor have we had any pronounced hemorrhages. The introduction of this apparatus has greatly facilitated and safeguarded the immediate convalescence after perineal prostatectomy.

Secondary hemorrhage may come on after the removal of gauze packs if these

are employed. We have never seen it occur at the removal of the rubber bag. It did occur at the end of a week in 2 cases. The cause is difficult to explain and the bleeding usually ceases spontaneously. Supportive measures should always be adopted at once and the patient kept quiet in bed. Should the bleeding continue and seem alarming, reinsertion of the drainage bag or repacking with gauze may be desirable. The following case, in which the bleeding was very pronounced, will give an idea of the management of such cases:

B. U. I. 12,766, aged fifty-five. Patient was admitted to the hospital September 5th, complaining of frequency of urination. Examination showed an enlarged prostate by rectum. Cystoscopic examination showed intravesical enlargement of the median lobe, completely obscuring the trigone. Medical consultation by Dr. Longcope with the following report, "The patient has the signs of well-compensated lesion of mitral valve and some enlargement of left side of the heart, combined with emphysema and history of bronchitis. There are no definite signs of bronchitis

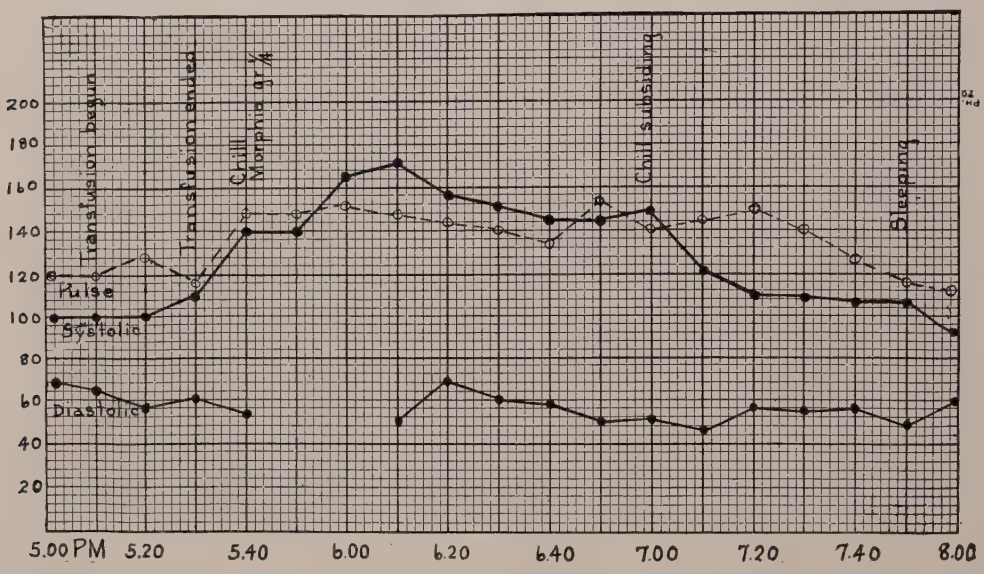


Fig. 832.—Chart showing the reaction to blood transfusion in a case of severe anemia following secondary hemorrhage one week after perineal prostatectomy. One hundred c.c. citrated matched blood was introduced at 5 P. M., pulse at that time being 120 and blood-pressure 100/60. At 5.40 P. M., ten minutes after end of transfusion, there was a chill and rapid rise in pulse, systolic blood-pressure, and simultaneous drop in diastolic blood-pressure which for forty minutes was too low to be taken. The shock following the transfusion lasted for almost two hours and was accompanied by a blood-pressure of 170. Reaction was quite terrifying and chill very severe. B. U. I. 12,766.

at present." The urine was infected with cocci. The phthalein had an appearance time of ten minutes, 47 + 10. Blood-pressure 162/90.

On September 8th, perineal prostatectomy by Dr. Young. The operation was begun under epidural anesthesia (25 c.c. of 2 per cent. solution of procain), but the patient was very nervous, complained of pain. Gas was administered for the last ten minutes of the operation. The Davis hemostatic bag was used.

He stood the operation well, showed no change in blood-pressure, and the urine became clear within four hours. Had severe bladder spasms the day following operation. The urine became slightly blood stained following the release of the fluid in the bag. The bag was removed in forty-eight hours after operation. The wound appeared in excellent condition and there was no bleeding. Patient was up in chair on the fourth day. Nothing eventful happened until the sixth day following operation when he experienced a sharp pain in the perineal region and felt a gush of fluid. Examination of the perineal dressings showed about 30 c.c. of dark red blood-clots. Patient was very much excited, began having bladder spasms, but was quieted with

morphin. There continued to be a moderate amount of blood in the perineal drainage fluid for the next two days. On September 16th, forty-eight hours after the first hemorrhage was noted, the patient again had severe bladder spasms and expressed about 150 c.c. of blood-clots through the perineum. The pulse became rapid (120). Blood-pressure fell to 95/40 and the patient had the appearance of extreme shock. This transition occurred rapidly within forty-five minutes. A rubber drainage-tube was inserted through the perineal wound by Dr. Young and a gauze pack introduced around it. This apparently effectively checked the hemorrhage, but the patient became more shocked. A subpectoral infusion was begun but the blood-pressure continued to fall, reaching 80/30 at 3 P. M. A transfusion was given at 5.30 P. M., chart showing variations in blood-pressure and pulse following transfusion. Ten minutes after the transfusion was ended the patient developed a severe chill, the blood-pressure rose abruptly from 100/60 to 150/65, the rise continued until at 6.15, forty minutes after transfusion was ended, when it reached 170, systolic. It was interesting to note that during the period of high systolic pressure the diastolic did not rise and could only be determined with difficulty. The temperature rose to 103.6° F. and the pulse varied between 130 and 150 during the chill. One hour and a half after the end of the transfusion, the chill ceased, the pulse fell to 110, the blood-pressure to 110/50. Patient's appearance changed considerably, he became comfortable, mentally alert, and at 9 o'clock fell into a normal sleep. The urinary drainage stopped during the period of low blood-pressure, recommenced when the pressure rose and was only slightly blood stained.

The following morning the patient was comfortable, the drainage practically clear. Forty-eight hours after the tube and pack were introduced they were removed without any bleeding whatever. The preoperative hemoglobin was 80 per cent. One hour after transfusion it was 65 per cent. Two days after the hemorrhage a severe herpes labialis came on but cleared up four to five days later.

The subsequent course was uneventful. He was up in chair five days after the hemorrhage, voided first through the urethra twenty days after operation. At the present time (twenty-seven days following operation) he is up and about most of the time, has regained much of his lost strength, has a healthy looking wound, and is voiding about half the urine through the urethra.

Epididymitis.—This is the "bête noir" of all operations upon the prostate, and its cause is often difficult to determine. Very early in our work we were convinced of the great importance of avoiding injury to the ejaculatory ducts and preserving the floor of the urethra in as normal a state as possible as a preventive measure.

The work of Proust and Albarran, which we simultaneously done in France, was characterized by indifference to the ejaculatory ducts which were cut across and removed in practically every case. The result was epididymitis in such a large percentage of cases that Proust adopted ligature of the vas deferens at the upper end of the prostate as a routine part of the procedure, and Albarran ligated the vasa in the groins in all of his cases.

With the bilateral capsular incision, which we adopted after the third case by our perineal technic, epididymitis occurred only in a small percentage of cases, but regardless of the care that was taken to preserve the ejaculatory ducts it occurred in a certain number of them. In our London report of 450 cases epididymitis was found to have occurred in 15 per cent. A more recent study of cases here has shown about 8 per cent. to have epididymitis. It is prone to occur during the second or third week after prostatectomy at a time when the urine begins to flow through the urethra in larger amount and the perineal fistula closes. The passage of a sound or other instrumentation which may bruise the verumontanum is also a fertile cause of epididymal infection. On this account we avoid instrumentation, and when it is carried out try to keep close to the roof of the urethra with the sound so as to do no injury to the verumontanum.

The Treatment of Epididymitis.—When swelling, pain, and onset of fever in-

dicate the presence of epididymitis the patient is confined to bed with scrotum elevated, and ice-bag applied for several days. In almost all cases, after a short period, the acute symptoms disappear under this treatment. In rare instances the swelling goes on to fluctuation with marked adhesions to the skin of the scrotum and operative evacuation is necessary. One should be careful to make two incisions, each fairly small, so as to have no herniation of the testicular tissue. Small drainage-tubes and through-and-through irrigation are instituted and usually lead to prompt healing without fistulæ.

Recently intravenous injections of mercurochrome have been used in acute epididymitis.

Closure of Wound.—After the bilateral capsular technic, with careful preservation of the entire posterior urethra, wound healing was undoubtedly quicker than by the technic in which the entire prostate is enucleated through an inverted V capsular incision in one mass, but the advantages of the later technic, as remarked above, are that large intravesical lobes may be removed with greater facility. Practically little can be done to hasten closure. The insertion of a catheter through the urethra and fastening it in place is apt to lead to epididymitis, although it does unquestionably facilitate the closure in certain cases. The use of antiseptics to combat infection has the disadvantage that they interfere with granulation. With the use of very weak solutions, cleanliness without injury can be procured.

Our present routine is for the ward orderly to irrigate the superficial portion of the wound with 1 : 2000 meroxyl whenever the dressing is changed and after defecation. One to five hundred meroxyl is injected through the penile urethra and out through the perineal wound, generally on the eighth day. A fountain syringe is used and, as a rule, no difficulty is experienced in forcing the fluid through the external sphincter and out through the wound. This procedure separates the edges of the coapted urethra and usually initiates the escape of urine through the meatus. Previous to this, as a rule, interval urination has been established through the perineal wound.

One of the most remarkable facts of perineal surgery is that though a fairly large intravesical median lobe has been removed and the internal sphincter left dilated at operation, within a few days the internal sphincter functions and interval urination is established, no urine escaping except when the bladder is voluntarily emptied, although the urine comes only through the perineal wound—the external sphincter and sphincter medius playing no part in the micturition. During the convalescence, therefore, there is a marked difference between the comfort of a patient after perineal prostatectomy, in that he is dry and voiding at intervals, whereas in a suprapubic prostatectomy the abdomen is continually flooded with urine.

The Closure of the Fistula.—In a study of 450 cases there were 18 per cent. in which the fistula closed within the first week, 23 per cent. within fourteen days, and 56 per cent. in less than twenty-one days. The average length of time cannot be accurately taken owing to the fact that in some feeble and old individuals several months elapse before the fistula finally heals. In these 450 cases there were only 5 in which the fistula persisted after several months. Three of these were paupers who had practically no treatment after operation, and in the other 2 cases small fistulæ were present two years after operation and gave little trouble, a few

drops of urine only escaping during urination. In most cases the fistula heals without more attention to the wound than mere cleanliness.

Occasionally, curetting is advisable when the fistula heals slowly and the granulations look redundant. When the fistula is very small we use a "gimlet curette," which can be screwed into the finest fistulous tract and then forcibly and quickly withdrawn, thus removing the granulations. With the old bilateral capsular technic, passage of sounds was very rarely resorted to. Since adopting the inverted V capsular technic it is found more often desirable to pass a large sound in order thoroughly to dilate the wound at the membranoprostatic juncture and hasten the closure of the fistula. In some cases two or three dilatations may be advisable, but in only extremely rare instances (less than 1 per cent.) has a definite stricture formation been present. Routine passage of sounds, such as is advised after the suprapubic operation, is not necessary, and we think distinctly inadvisable after perineal prostatectomy, owing particularly to the danger of epididymitis, as stated above.

Urinary Control.—In describing the operation we stressed the importance of incising the urethra at the apex of the prostate well back of the external sphincter. As a result, in the very large majority of cases perfect urinary control is present before the patient leaves the hospital and, as stated above, in many cases before the perineal fistula heals. Slight weakness when the patient coughs, sneezes, or makes a sudden movement is not infrequently present, but rapidly disappears either before or shortly after leaving the hospital. In extremely rare instances a slight incontinence persists. A study of our first 450 cases showed 3 in which such incontinence persisted several years after operation. None of these cases has incontinence at night. Two were carefully examined and showed dilated internal sphincters, pouch-like posterior urethras, and slightly dilated external sphincters. In one of these cases the transversus perinei muscle, the triangular ligament, and probably the external sphincter were injured at operation and it is probable that imperfect operative technic was responsible for the other 2 cases. We are confident that where the operation is properly done and the prostate is exposed through a wound well back of the musculature of the perineum, incontinence of urine almost never occurs.

Sometimes a supposed incontinence is due to slight stricture of the urethra and loss of elasticity, owing to fibrous tissue. Passage of a few sounds will usually dispel the "incontinence." In other cases the necessity of re-educating the perineal muscles is evident and if the patient simply practices efforts of contraction during urination, urinary control is quickly established. As a routine, where the patient complains of slight incontinence, he is told to retain his urine as long as possible in a sitting or lying posture, and when he urinates to attempt to stop the outflow several times during each urination and thus practice his sphincter muscles. By this means most cases soon get urinary control. In a few cases in which the patient has complained of slight incontinence or especially if the act was unsatisfactory, further investigation has shown a lobule or polyp which remained at the vesical orifice or in the prostatic urethra and prevented complete closure at the end of urination, or a pouch persisted from which the urine would escape. These conditions have been relieved by a punch operation or even by fulguration. In a few cases a second operation, either perineal or suprapubic, was necessary to clear up the situation.

Where incontinence persists for many months or years and the internal and external sphincters are both dilated, our combined internal and external plastic operation upon the two sphincters offers a very satisfactory and practically certain method of cure.

The following case is a remarkable example of abnormal wound healing:

B. U. I. 12,135, aged seventy-five, admitted January 4, 1924. Prostate was considerably enlarged, residual urine 810 c.c.; preliminary treatment required for twelve days. On January 16th perineal prostatectomy was carried out by the usual inverted V capsular technic. Prostate was enucleated in one piece and was about 3 inches in diameter. Internal sphincter was greatly dilated but apparently not torn; 6 large packs were required to stop the hemorrhage. Convalescence was slow on account of the persistence of the perineal fistula, and at the end of four weeks sounds were passed through the membranous urethra without difficulty but intentionally not as far as the bladder. This procedure was repeated several times and as no stricture of the membranous urethra or apex of the prostate was encountered we could not understand why no urine passed through the anterior urethra. Finally efforts were made to pass the sound into the bladder and it was found impossible.

Under general anesthesia an investigation was then made and it was found that there was a perineal fistula directly into the bladder and in front of it there was a septum which separated it from the anterior part of the prostatic urethra. This septum continued down to the bladder orifice and formed a complete roof over the fistula. At operation a large clamp was passed through the penile urethra and a scalpel through the perineum, the septum was divided upon the clamp, thus reuniting the prostatic urethra with the vesical orifice. The fistula was then curetted, a catheter was placed through the urethra into the bladder, and the bladder and perineal wound then healed without delay. The final result in this case was excellent.

Postoperative Infection.—Local infection of the wound and of the bladder not infrequently occurs, occasionally the wound opens, and in rare instances in extremely feeble and aged patients, in whom the resistance is greatly lowered, one sees sloughing of the tissues. During the past year we have had a protracted epidemic of infection from a peculiar and hitherto undiscovered Gram-positive bacillus, which caused an extensive necrosis of the tissues.

The *wound surface* in these cases had the appearance of a black eschar and in other cases the wound was covered by a very thick whitish, sticky, alkaline exudate. Cultures have shown a new organism, the corynebacterium Thompsoni (see Chapter III, Bacteriology). After trying various antiseptics we found that 1 per cent. acetic acid was a rapid means of eradicating this infection. By the use of meroxyl (1:2000) or $\frac{1}{2}$ per cent. mercurochrome as wound irrigations or injections, infections have been kept at a minimum. As remarked above, one must use weak antiseptics so as not to interfere with rapid granulation and wound healing.

Cystitis, which is usually present before operation, may become aggravated after operation. This is best treated by water in large amounts by mouth, and only rarely have we found it advisable to give vesical irrigations through a catheter. Urotropin in large doses may sometimes be desirable. When the onset of fever indicates an inflammation, the location of which is uncertain, a careful physical examination is at once instituted. The nasopharynx is carefully examined and if evidence of an acute infection is discovered active antiseptic treatment, generally with the advice of the nose and throat department, is undertaken at once. It is thus possible often to abort the infection in its early stages. If evidence of bronchitis or pneumonia is at hand, proper measures are at once adopted. Intravenous mercurochrome is sometimes indicated.

Pyelonephritis is one of the most frequent and dangerous postoperative infections. It is usually accompanied by pain and tenderness in the region of one or both kidneys and occasionally muscle spasm and a palpable mass may be detected. Water is here most important therapeutically, hydrotherapy being carried out by mouth, subcutaneously and, in grave cases, intravenously. Such patients have received from 10,000 to 12,000 c.c. of water per day and almost invariably the infection is literally washed away within a few days. We have seen desperately ill cases with high fever and marked tenderness in the kidneys, sometimes the patient being practically comatose, in which this simple treatment of forced water has brought about a veritable transformation in a little time. As a result of this, we insist on forcing water from the beginning of the convalescence and, in fact, before operation, as stated above, and we are confident that many infections of the kidneys are thus prevented.

Fever of undetermined origin is not rare. The following case shows a remarkable result with intravenous mercurochrome:

Sepsis of unknown origin, coming on two weeks after prostatectomy. Daily temperature 104° F. *Two weeks later, intravenous mercurochrome. Rapid recovery.*

B. U. I. 13,261, admitted February 26, 1924, complaining of frequency of urination. Diagnosis, prostatic hypertrophy and cystitis. March 3d, perineal prostatectomy. Convalescence uneventful until March 13th, when patient had chill and temperature rising to 103° F. Every day for two weeks patient had a daily septic temperature between 103.5° and 104.6° F. Leukocytosis 18,250. General condition bad; prognosis unfavorable. Careful examination failed to reveal any localization of infection. Kidneys and bladder apparently negative. Wound not unusual. Blood-cultures negative. March 27th, slight tenderness in right kidney. March 31st, daily fever continues. Condition of patient desperate. Mercurochrome-220, 1 per cent., 18 c.c. given intravenously. This was followed by severe chill, rise in temperature to 106° F., followed by rapid drop to 97° F. (fall of 9 degrees). After that temperature did not rise above normal, patient rapidly improved in strength, and he was discharged ten days later, wound healed and in apparently excellent condition. This case is an excellent example of the immediate results obtained in continued septic conditions by intravenous injections of mercurochrome.

The *course of convalescence,* however, is usually free from the series of disasters which have been detailed above. The routine followed in most cases is this: Within three or four days after operation, all drainage having been removed, the patient is placed in a wheel-chair and taken out-of-doors. Within a week he is generally walking for a short period morning and afternoon, and as interval urination is then usually established (although through the perineal wound) no great discomfort is encountered. This is in marked contrast to the early convalescence after suprapubic prostatectomy, in which the patient is usually unable to walk and is flooded with urine. The stay of the patient in the hospital depends on the closure of the fistula. Where the patient lives in town or when it is urgently necessary that he return home quickly he may be discharged before the third week. One patient, a restless physician, even left on the fourth day and got a good result. In most cases we insist on their staying until the fistula has been healed for four days, and this naturally protracts the residence in the hospital. In our report of 450 cases the average length of stay was twenty-three days.

For the first few days after operation water is forced and the patient consumes about 4000 c.c. of water daily. When interval urination through the urethra ensues the amount of fluid is usually reduced to facilitate the closure of the fistula. The management of bowel movement is most important. Shortly after operation

distention may give not only great discomfort but grave concern. As a preventive of this the use of a mineral oil before operation is desirable, and after operation it is again given, ½ to 1 ounce twice daily. On removal of the drainage 1 ounce of castor oil is often ordered, and if distention is present one ampule of "surgical pituitrin" is given and repeated, if necessary, about every two or three hours until four doses are taken. This is usually followed by an expulsion of gas and eventually satisfactory bowel movements. In very obstinate cases other measures, described more in detail under the postoperative treatment of kidney cases, are carried out. During the remainder of the convalescence regular bowel movements are obtained by proper catharsis. Enemata are never to be used on account of the danger of embolism. It may sometimes be necessary to remove inspissated feces with the fingers.

Abdominal distention is not infrequently associated with marked nausea and vomiting. In such cases the blood urea is at once taken to determine whether renal suppression has supervened, and if so, energetic diuretic treatment adopted (forced hydrotherapy, heat to the abdomen and flanks, and digitalis where cardiac as well as renal conditions exist). In 1 case, after the removal of drainage with very slight hemorrhage, on the second day after operation the patient's pulse became very rapid and was hardly perceptible The systolic blood-pressure fell to 65. He was given caffein, 3 grains, with no benefit, and in a few hours the blood-pressure had fallen to 48. He was then given 500 c.c. 10 per cent. glucose intravenously and an infusion of salt solution beneath the breast. Six hours later his blood-pressure had not increased; he was given 400 c.c. of 20 per cent. glucose intravenously, but even after this most active treatment ten hours later the blood-pressure had only risen to 67/45, although there was distinct subjective improvement, and he began to void urine—having been anuric for twenty-four hours. On the following day the blood-pressure was 90/65 and two days later 128/80. The condition of the urine was satisfactory. The patient ultimately made a good convalescence.

Next to the urinary tract the gastro-intestinal tract requires the greatest attention in all operations upon the urinary tract and only by the greatest care as to the bowel movements, can serious complications be avoided in the very weak and aged. It is by such care and attention on the part of the faithful house officers, interns, and nurses in a well-regulated hospital that these very infirm old men, often in desperate condition as a result of urinary back pressure and infection, can be carried satisfactorily through perineal prostatectomy. It is such work that has made possible a series of 198 consecutive perineal prostatectomies in this hospital, without a death.

Suprapubic Prostatectomy.—*Anesthesia.*—If general anesthesia is to be employed, the directions which have been given for the operation of perineal prostatectomy will apply. In brief, nitrous oxid and oxygen anesthesia is preferable to ether, which is employed generally in cardiac cases only. Spinal anesthesia may be used very effectively, but epidural or caudal anesthesia is usually not satisfactory, because the suprapubic region is not anesthetized. Local infiltration anesthesia with procain is quite satisfactory and may be used either in the line of incision and of enucleation, or as a block anesthesia around the suprapubic region. When local procain anesthesia is used, after the bladder is exposed, a line of infiltration is made in the anterior wall of the bladder, which is then opened. The bladder is retracted, exposing the prostatic orifice, around which another ring

of infiltration is made, and then injections are made into the depths of the prostate and prostatic urethra. Exceptionally long straight and curved needles have been devised by Legueu for this work. This method is very satisfactory and has been employed by numerous operators. Where the patient is in good condition, we believe a light general anesthesia preferable.

Position of Patient.—We employ our special urologic table in the Trendelenburg position, with the legs hanging over the knee crutches. This table makes it possible for the operator or assistant to work between the separated thighs in passing catheters or introducing the finger into the rectum during the operation. An assistant can also stand in this position most conveniently to make retraction toward the symphysis pubis. The bladder is catheterized. We usually employ either a silver catheter or a coudé gum catheter to evacuate the bladder and wash it out with a weak antiseptic solution (1 : 500 meroxyl or 1 : 4000 oxycyanid of mercury), and then fill the bladder with air until it is fully distended. Generally 400 to 500 c.c. of air should be introduced. The advantage of the distention is that it carries the peritoneum upward and exposes the anterior surface of the bladder for incision, without danger of injuring the peritoneum. The catheter is then removed, and antiseptic preparation for the operation made.

Incision of Skin.—This will depend upon the character of the operation to be done. If the operator desires only to open the bladder widely enough to insert the finger for enucleation of the prostate, and its subsequent removal from the bladder, a suprapubic incision 8 cm. long will usually suffice. If it is desired to get a complete exposure of the interior of the bladder and the intravesical portion of the prostate, a longer incision will be required, particularly in fat men.

Suprapubic Prostatectomy, Without Intravesical Inspection.—Having opened the bladder through a small stab wound in the median line, the finger is inserted and the prostatic mass quickly examined to determine its size and configuration. The prostate may then be attacked in three ways: (*a*) The method of Fuller[1]: Having located the vesical opening of the urethra, long scissors are slipped along the forefinger into the urethral opening and are made to cut through the median bar or lobe. The cut extends from the lower region of the internal vesical opening of the urethra backward for 2 to 3 cm., and into this the forefinger is inserted while counterpressure is made against the perineum with the fist of the other hand. The prostate is then enucleated *en masse*. (*b*) Suprapubic enucleation with the assistance of a finger in the rectum. This method was employed by us on our first case, as mentioned before, in 1898.[2] The gloved finger of the left hand is introduced into the rectum and the right into the bladder; with the finger-nail, a tear is made in the mucous membrane covering the most prominent intravesical portion of the prostate, generally on the right side. Enucleation is then begun externally, pushing the mucous membrane covering the prostatic lobe and the vesical neck away. Working back and forth, the finger passes well within the interior of the prostate, enlarging the wound as it goes, hugging the hypertrophied mass and thus passing between it and the non-hypertrophied portion of the prostate which surrounds the hypertrophied lobes. When the anterior surface

[1] The Question of Priority in the Adoption of the Method of Total Enucleation, Suprapubically, of the Hypertrophied Prostate, Annals of Surgery, 1905, xli, 520–534.

[2] Young: Transactions Virginia Medical Society, 1898, and also Guiteras in 1900, Transactions of the International Medical Congress, Paris.

of the prostate has been reached, the operator separates the lobes as completely as possible from the mucous membrane of the urethra, and breaks through the adhesions at the anterior or deepest limit of the lobe near the apex of the prostate. Sweeping backward, the same process is carried out with the median lobe. Pressing downward, the finger passes immediately behind the posterior surface of the median lobe and above the ejaculatory ducts. When the urethra is reached, it is separated from the lower portion of the middle lobe, but in so doing is usually broken into a short distance above the verumontanum. Carry-

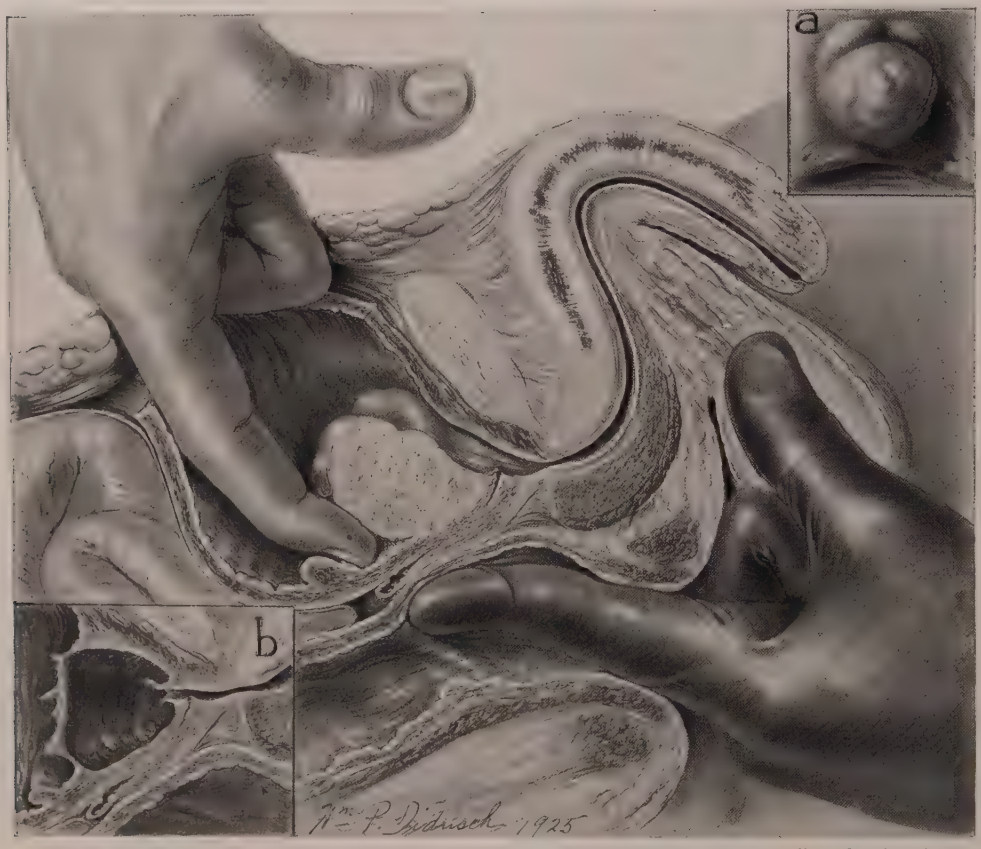


Fig. 833.—Suprapubic prostatectomy with assistance of finger in rectum. Enucleation begun externally after breaking through or incising mucous membrane at outer edge of intravesical projecting prostatic lobes. *a*, Through this opening the finger is inserted and the enucleation carried out laterally and posteriorly as shown in main picture. Lateral, median, and sometimes anterior hypertrophy is removed in one mass, the final act being to break through the mucous membrane near the apex of the prostate. Insert *b* shows the urethra ruptured just above the ejaculatory ducts and torn edge of the vesical mucosa adjacent to the cavity left by removal of the prostatic lobes.

ing the finger further around to the left, the left lateral lobe is enucleated externally, and also separated from its attachments to the deeper portions of the prostatic urethra. During this procedure, the finger in the rectum is engaged in pushing the prostate upward as vigorously as possible and is of much assistance in forcing the deeper portions up so that they can be more easily reached by the enucleating finger. When the prostate has been completely freed, the rectal finger is of assistance in delivering the prostate into the vesical cavity. By this method of enucleation, the anterior commissure is usually not removed with the rest of the

prostate. Freyer,[1] as a rule, removed the anterior commissure along with the lateral lobes, and in so doing, generally brought away more of the capsule immediately surrounding the hypertrophied lobes than we were accustomed to do. Sometimes the normal fibromuscular structures of the anterior portion of the prostate were included, as seen in photographs of his specimens. This can be avoided by hugging more closely to the substance of the hypertrophied lobes at their anterior margin and avoiding the removal of the anterior portion of the urethra. It can be more effectively prevented by breaking through into the urethra along the anterior margin of the hypertrophied lateral lobe and completely avoiding the urethral roof. When a hypertrophy of the anterior portion of the prostate is present, it is essential

FIG. 834.—Suprapubic prostatectomy, intra-urethral enucleating method. The finger, which has been introduced into the prostatic urethra as far as the apex and has torn through the mucous membrane in front of the lateral lobes on each side, is shown pushing the median lobe of the prostate backward into the bladder along with the lateral lobes. Enucleation may be in one piece or separately, depending on how closely attached the lobes are to each other. Insert *a* shows the Hagner bag drawn into the cavity to stop hemorrhage.

to remove the roof of the urethra and perhaps some of the anterior commissure immediately adjacent to the hypertrophied anterior lobule, as has been shown in a description of the perineal enucleation *en bloc*. (*c*) A third method of suprapubic enucleation consists of the "intra-urethral method" fully described by Squier.[2] The forefinger of the right hand is inserted as far as possible into the prostatic urethra until the lower ends of the hypertrophied lobes are reached. The mucous membrane of the urethra is then broken into on each side just in front of the lower portions of each lateral hypertrophied lobe and, working from within upward, the adenoma is enucleated from the pathologic capsule and the surrounding normal prostate. This is carried rapidly backward, sweeping completely around the hypertrophied lobe and

[1] British Medical Journal, 1901, ii, 125–129.

[2] Boston Medical and Surgical Journal, 1911, clxiv, 911–917.

breaking its attachments with the capsule and the urethra in all directions. Having liberated the two lateral lobes, the mucous membrane along the floor of the urethra is broken through where it joins the median lobe. Effort should be made to avoid injury to the verumontanum and ejaculatory ducts by hugging the middle lobe at this point, passing the finger carefully upward and away from the ejaculatory ducts. Having freed the lateral and median portions of the prostate along the inferior and lateral aspects, the prostatic mass begins to project into the bladder, but still covered by the vesical mucosa. This is stripped off from the lateral and posterior surfaces of the prostate as much as possible, but the enucleating finger usually breaks through it near the summit of the hypertrophied intravesical mass, both lateral and median, so that when the entire prostate is dragged into the bladder, the inner surfaces of the lateral and median lobes are usually found covered with urethral and vesical mucous membrane. In carrying out these enucleations, not infrequently considerable difficulty is experienced in breaking through the deeper adhesions of the prostate, either lateral or urethral. The presence of a strong, sharp finger-nail is at times of great assistance, but sometimes it is necessary to change hands and use the left forefinger for the left lobe of the prostate, the operator changing position to the right side of the table.[1]

Suprapubic Prostatectomy Under Visual Inspection; the Open Operation.—Where the prostate is fibrous and the adhesions very marked and difficult to free, suprapubic prostatectomy may be extremely difficult and an unsatisfactory procedure. Not infrequently, deeper portions of the hypertrophied lobes have been left behind, as shown by numerous autopsy specimens. These facts have led Thompson Walker, Judd, and others to advise suprapubic prostatectomy under visual inspection through a much wider suprapubic opening. We quote freely from Thompson Walker's paper:

Having carried out the enucleation of the prostate as practised by Freyer, we now depart from his technic. Instead of irrigating the bladder with hot solution, a catgut stitch is passed through each lip of the suprapubic wound and the patient is placed in the full Trendelenburg position. A good head-lamp is essential for this part of the operation. I then introduce my bladder retractors. A gauze swab is pushed into the prostatic cavity to control bleeding temporarily and the bladder is emptied of clot. When this is done, the plug is removed and a careful inspection of the prostatic cavity and its inlet into the bladder is made, hemorrhage first claiming attention. In most cases bleeding is in progress and spouting arteries are seen in some. The arterial bleeding comes almost invariably from an artery situated at the brim of the vesicoprostatic entrance, slightly behind the midcoronal line. There is usually a spouting vessel on each side in this position (Fig. 835). This artery surrounds the neck of the bladder and can frequently be felt in a normal bladder, beating against the finger at the internal meatus, when the finger is introduced. It is found spouting at the brim of the prostatic cavity just below the mucous membrane. Long forceps are placed on these vessels. With my handled bladder needles, a catgut stitch is placed through the mucous membrane of the bladder and the sphincter, or what remains of it, appearing in the prostatic cavity below the brim. This is passed anterior to the forceps and tied and the forceps removed. A second hemostatic stitch is placed in the other side of the cavity (Fig. 836). These two stitches now act as tractors to pull up the neck of the prostatic cavity. The arterial bleeding from the wall of the bladder can be seen but is not frequent. Venous hemorrhage may be copious. Forceps are applied to any bleeding points and the tissues in their grasp crushed. This bleeding mostly comes from the anterior wall of the prostatic cavity where the periprostatic plexus of veins is most pronounced. In 2 cases, where the venous bleeding from this source appeared threatening, I pushed the anterior wall of the bladder backward and stripped the anterior wall of the prostatic cavity from its light attachment to the back of the symphysis pubis and then with one of my long handled bladder needles,

[1] See discussion, History of Technique of Prostatectomy, Young, in Keen's Surgery, iv, 434.

passed a catgut stitch transversely through the wall of the prostatic cavity and tied it so as to compress the vertical limb of the prostatic plexus. In practically all cases it is sufficient for the

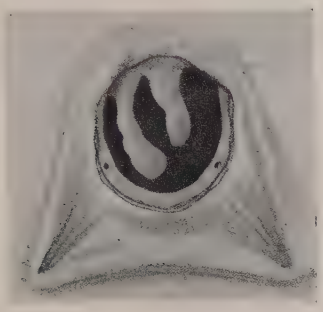


FIG. 835.—Tags which are often found after prostatectomy. Thompson Walker.

FIG. 836.—Placing a suture ligature around artery on each side. Thompson Walker.

arterial bleeding to place a hemostatic stitch on each side at the brim of the prostatic cavity and to plug the cavity temporarily. Sometimes these may be omitted and the crushing by

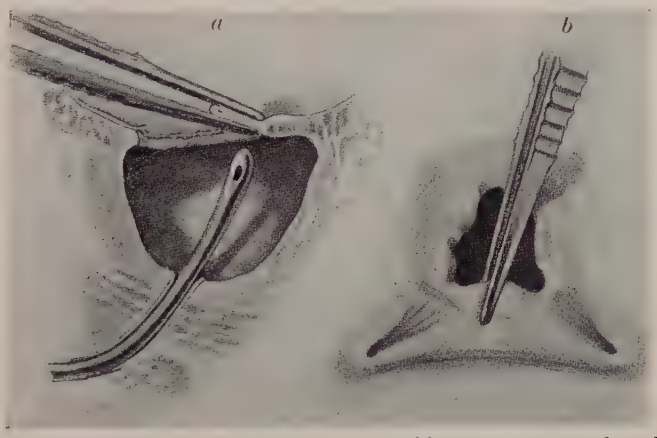


FIG. 837.—Conditions present at vesical orifice after suprapubic prostatectomy, the valve-like posterior flap is shown held by forceps. Thompson Walker.

the artery forceps relied upon to control the bleeding. In exceptional cases I have had to plug the prostatic cavity with gauze around a urethral catheter. Having controlled the hemorrhage

FIG. 838.—The posterior valve-like flap has been excised with scissors. Thompson Walker.

by suturing, as above described, the next step is to attempt to remove all tags, flaps, strips, or nodules, in order to avoid postoperative obstruction or valve formation. A large variety of these occur. It is a revelation, when one comes to examine the prostatic cavity after enucleation of

the prostate, to see the number, size, and variety of these loose masses of tissue. All loose tags, etc., tend to slough and are ready soil for the growth of bacteria, or may form valves and obstructions. All these are carefully clipped away and the mucous membrane is trimmed at the outer edge of the cavity. A fold lying at the posterior lip of the prostatovesical opening is picked up with forceps (Fig. 837), and a wedge with its base forward cut out of it with long curved scissors (Fig. 838). The tissue removed consists of mucous membrane, trigonal muscle, and frequently some gland tissue. This effectually removes any possibility of narrowing of the vesicoprostatic opening. In 1904 I pointed out that the action of the internal vesical sphincter was destroyed by a suprapubic prostatectomy. The sphincter action is taken up by the compressor urethræ, which effectually prevents the escape of urine. The prostatic cavity thus forms a prolonged neck communicating with the bladder cavity.[1]

F. R. Hagner,[2] in 1914, presented an inflatable rubber bag to be used by traction through the urethra to prevent hemorrhage following prostatectomy. This has been used most successfully by numerous surgeons and, besides stopping hemorrhage, has the advantage of dilating the internal orifice and preventing the formation of the valves or bars described by Thompson Walker. This bag has been modified by Pilcher so as to provide urethral drainage as well as hemostasis. The latter is the forerunner of the Davis perineal drainage-bag which we have adopted.

Postoperative Treatment.—Before the patient leaves the operating room one should be sure that his condition is satisfactory. Bleeding should have been practically stopped, the pulse of the patient fairly good and no pronounced shock present. If the patient is shocked, an investigation should be made of the wound to see if the bladder is filled with blood, and if so, the prostatic cavity should be packed with gauze or a Hagner bag introduced. It may be advisable to give an intravenous infusion before the patient is returned to the ward. Morphin, caffein, and other supportive hypodermic injections may be desirable. When the patient is returned to the ward the treatment which has been outlined for cases of perineal prostatectomy is equally applicable to suprapubic cases. A routine submammary infusion of 1000 c.c. of salt solution is carried out in our clinic, generally distributed beneath the two breasts, the needle being placed well beneath the pectoral muscles through a puncture 2 or 3 inches external and below the nipple. Should increasing rapidity of the pulse or pronounced hemorrhage in the dressing or through the drainage-tube indicate continuation of the bleeding, opening of the wound and repacking, etc., may be indicated. If the patient is markedly shocked and very pale, arrangements should be made at once to do a blood transfusion from some acceptable donor, previous studies having been made so that the blood group is known beforehand and the matching can be carried out without delay.

After operations under general anesthesia it is wise to keep the patient fairly quiet and to give him little fluid in the first six hours. Where local, spinal, or sacral anesthesia has been employed, water may be given at once and in increasingly large quantities and will go a long way to replace fluids lost at operation. In old men it is important to avoid hypostatic congestion of the lungs, and on this account the patient should be changed in position, propped up in bed, and given light massage to improve the circulation. The wound should be watched carefully for extravasation and suppuration. Should the exit tube become blocked it is possible for extravasation to occur within the sheaths of the recti muscles.

[1] J. Thompson Walker: Transactions Second Congress International Association of Urology, London, 1911.

[2] Surgery, Gynecology, and Obstetrics, 1914, xix, 677–678.

These conditions should be detected early and cared for either by reopening of the wound and providing appropriate drainage or by incisions through the skin and muscles to allow exit for the extravasated urine or pus. One of our patients came to a fatal ending as a result of suppuration within the rectus sheath pointing posteriorly toward the peritoneal cavity just below the umbilicus. This is difficult to recognize, in fact, we did not appreciate its presence, which was found at autopsy. Careful examination should prevent such a mistake.

At the end of a week the large suprapubic tube is removed and a small tube or a mushroom drain introduced. This may often be removed at the beginning of the second week and the suprapubic wound allowed to heal. Silver wire sutures are removed in about eight or nine days unless suppuration is present, when they are allowed to remain longer. The infection is combated by opening the skin wound sufficiently and applying vigorous antiseptic treatment. The advantage of these through-and-through antiseptic silver sutures is that healing may be secured, even though suppuration has occurred, without separation of the muscles. During the third week the patient usually voids naturally in small amounts through the urethra. If this does not occur, it is advisable to pass a sound or catheter into the bladder after antiseptic injection in order to open up the urethra. Some advise the regular use of sounds and some the insertion of an inlying catheter, but both of these procedures increase the danger of epididymitis and are not necessary unless definite evidence of stricture formation or a prolonged continuation of the suprapubic fistula require active efforts to close the wound.

If epididymitis occurs the treatment is the same as that previously outlined, elevation, ice-packs, and sedatives. If suppuration occurs at points beneath the skin, opening generally in two points with through-and-through drainage with irrigation is desirable. Intravenous antiseptic therapy may be indicated in suppurative conditions either in the epididymes, kidneys, or locally in the region of the bladder and prostate. This is discussed elsewhere. Continued presence of fever indicates either septic absorption or some local focus of infection. The lungs may be the cause, and careful examination should be made at once to determine whether an early pneumonia or simply bronchitis is present and vigorous measures taken to combat it. Pyelitis is usually indicated by tenderness and occasionally by swelling in the region of the kidney, but often little or no evidence is present in early renal infections. The patient should be made to drink water in large quantities, and if the fever persists, submammary saline infusions and water by rectum should also be given. As remarked elsewhere, we have seen numerous cases in which acute pyelonephritis has been washed out by active hydrotherapeutic measures.

If the suprapubic fistula persists despite the measures indicated above, a careful examination should be made with the cystoscope or endoscope in search of obstructions at the vesical orifice, lobules, valves, septa or complete closure of the prostatic orifice or stricture of the membranoprostatic urethra. The literature contains numerous instances in which even complete obliteration of the prostatic space has occurred, as illustrated in the following case:

Suprapubic prostatectomy; enucleation of the adenoma in one piece; complete obliteration of prostatic orifice requiring suprapubic operation and incision.

B. U. I. 4947, W. C. E., age sixty-five, admitted March 9, 1916. Difficulty of urination for eighteen months; voiding every two to four hours with considerable hesitancy and urgency.

Examination: Patient is a strong, healthy man; prostate moderately enlarged; residual urine, 80 c.c.; bladder capacity, 400 c.c. Cystoscope shows a very large, globular median lobe; no enlargement of the lateral lobes; in the bladder is a calculus about 3 cm. in diameter.

March 31, 1916: Operation, Young; gas, nitrous oxid, oxygen, and ether. Operation begun for perineal prostatectomy; incision too far forward; accidental rupture of bulbous urethra with sound by assistant who was holding it in urethra. Decision was then made to remove the prostate suprapubically; perineal wound closed in three layers. Suprapubic prostatectomy and lithotomy; a finger was inserted into the urethra and the median and both lateral lobes removed in one piece; internal sphincter found considerably dilated and somewhat torn; no packing placed in the prostatic cavity, bleeding being slight; suprapubic drainage provided.

Convalescence: April 16th suprapubic tube removed; April 19th suprapubic fistula small, no urine through urethra; May 2d no urine has passed through urethra, attempts to pass filiforms, sounds, and cystoscopes through the urethra into the bladder unsuccessful; May 22d suprapubic cystotomy; prostatic orifice found completely closed; mucous membrane had healed smooth over the prostatic cavity. A sound was then passed into the urethra and the dam of tissue was found to be thin. It was easily incised with a scalpel upon the end of the sound and the margins were then excised, the tissue removed being hard and fibrous. Large sounds were then easily passed into the bladder. The posterior urethra was found to be dilated with a pouch beneath the trigone.

Suprapubic wound healed and patient was discharged June 12th, voiding urine freely at intervals of three hours. He subsequently returned twice with calculi, which were removed. Final report July 6, 1920: "Condition excellent; fistula closed; void urine at intervals of three hours, 500 c.c. at a time."

It is even possible for the rectum to be injured at operation, as shown by the following case:

Suprapubic prostatectomy; injury of rectum; recto-urethral fistula; cured by perineal operation.

B. U. I. 11,734, W. R. T., age sixty-three, admitted September 18, 1923. A suprapubic prostatectomy was done elsewhere in July, 1922, and following this a recto-urethral fistula was present. It was impossible to obtain any details of the operation, but it was evident that a tear was made into the rectum during the prostatic enucleation. Two operations had been performed in an effort to cure the fistula, without result. Urine still passes through the rectum and gas through the penis; urination every hour night and day. On rectal examination fistula can be felt in the midst of prostatic scar about 2 cm. above the anus. Cystoscopy: No residual urine, bladder capacity, 125 c.c.; small oval calculus present; in the floor of the prostatic urethra the orifice of the recto-urethral fistula can be seen. Urine cloudy with pus and bacilli; phthalein—appearance time, ten minutes, 65 per cent. in two hours.

October 1, 1923: Operation, Young; gas, ether. Suprapubic cystotomy to remove stone and supply drainage. Small hypertrophied prostatic lobule was also removed. The operation for fistula was carried out according to method described elsewhere (page 582). There were marked adhesions between rectum and prostate which were divided. The rectum was drawn out until the fistula could be excised with a margin of rectal mucosa. The opening into the prostate was closed with catgut and the rectal mucosa and the skin approximated as usual; suprapubic drainage supplied.

October 27, 1923: It is now twenty-six days since radical operation for cure of recto-urethral fistula. Convalescence satisfactory; suprapubic drainage maintained for two weeks; there has never been any leakage of urine through the perineum, which is now well healed. Suprapubic wound has now been closed for six days and patient voids freely at intervals of three or four hours. Rectal examination shows the rectal wall normal; control of bowels fairly good.

August 15, 1924: Patient returns for examination. Says he is entirely well; voids urine normally; examination entirely negative; condition excellent.

After the suprapubic wound is healed the subsequent treatment will depend on the condition of the patient, result of the operation, character of micturition, and the presence of infection. If urination is difficult or frequent, investigation

should be made to determine the presence of valves or other obstructions with residual urine. A stone may be present either in the bladder or prostatic cavity. Appropriate measures should be taken to combat these conditions. Not infrequently the punch operation has been used to remove valvular or bar-like obstructions at the prostatic orifice. Fulguration has likewise been employed, but the use of large sounds may alone be sufficient.

Persistent residual urine may be due to diverticula which, if producing symptoms, may require diverticulectomy. A slight vesical infection is practically always present and gives little trouble. If pronounced, and particularly if accompanied by burning, irritation, pain, or fever, it should receive appropriate treatment—antiseptic irrigations, water in large amount by mouth, or internal antiseptics.

Many of the imperfect results of prostatectomy, either suprapubic or perineal, are due to inadequate postoperative treatment. The surgeon's responsibility does not cease with the simple removal of the prostate, but before the patient is finally discharged the urinary tract should be placed in as perfect condition as possible, and infection eliminated lest serious consequences ensue.

The sexual powers are always impaired for a protracted period after prostatectomy. The patient should be warned not to attempt intercourse until strongly impelled by nature and not to be disturbed about the temporary absence of erections. Much worry and postoperative neurasthenia will thus be avoided.

Results of Suprapubic Prostatectomy.—A study of the records of our clinic shows that among 12,500 cases and over a period of twenty years there have been 130 cases subjected to suprapubic prostatectomy. During this same time about 1800 cases have had perineal prostatectomy. In some of the early cases the records are not sufficiently complete and accurate to be included. We present here an analysis of 108 cases in which every effort has been made to obtain the immediate and ultimate result.

The ages of the patients are shown in the following table:

TABLE 158

Age.	Cases.	Per cent.
46–50	9	8
51–55	11	10
56–60	18	17
61–65	19	18
66–70	22	20
71–75	17	16
76–80	11	10
Over 80	1	1

As seen here, 8 per cent. of the cases were under fifty years of age which is rather remarkable, and 27 per cent. over seventy years of age.

Symptoms had been present less than one year in 5 cases; one year, 16; two years, 22; three years, 13; and in the rest of the cases four years or more.

Symptoms on admission were as follows: Frequency 94 per cent., difficulty 76 per cent., urgency 42 per cent., small stream and weak force 36 per cent., complete retention of urine 33 per cent., incomplete retention 5 per cent., sudden stoppage 5 per cent., incontinence 13 per cent., history of calculus 6 per cent.; pain, end of penis 13 per cent., bladder neck 7 per cent., perineum 7 per cent., suprapubic 4 per cent., dorsal 1 per cent.

Examination showed the prostate enlarged in 85 per cent., indurated 41 per cent., nodular 37 per cent., adherent 25 per cent., irregular 12 per cent., nodular 3 per cent., atrophic 1 per cent. The seminal vesicles were indurated in 17 per cent., adherent 12 per cent., enlarged 7 per cent., nodular 5 per cent. Urine contained pus cells in 70 per cent., albumin 33 per cent., R. B. C. 8 per cent., sugar 0, casts 0.

Cystoscopic examination showed residual urine over 200 c.c. in 26 per cent., between 50 and 200 c.c. in 25 per cent., under 50 c.c. in 12 per cent., incontinence 13 per cent., no residual urine 6 per cent. A middle lobe was present in 45 per cent., right lateral enlarged 55 per cent., left lateral 57 per cent., anterior bar or lobe 3 per cent., calculus 20 per cent., trabeculation 42 per cent.

Phthalein Tests.—Adequate records are present in 65 cases and tests showed as follows:

TABLE 159

RENAL FUNCTION (PHTHALEIN)

Per cent.	On admission. Per cent. of cases.	Before operation. Per cent. of cases.	After operation. Per cent. of cases.
Under 10	4.6		
15–20	6.9	2.3	
21–25	6.9	2.3	2.7
26–30	9.2	6.9	2.7
31–35	9.2	2.3	
36–40	11.5	6.9	10.8
41–50	25.3	32.2	21.6
51–60	2.3	16.1	37.8
Over 60	13.8	20.7	24.3

TABLE 160

REASON FOR SELECTING SUPRAPUBIC ROUTE

	Cases.
Previous perineal prostatectomy	19
Perineal operation abandoned, tear in rectum	7
Vesical calculus	22
Suprapubic for drainage	13
Suprapubic fistula on admission	14
Excision of bladder tumor	5
Enlargement entirely intravesical	3
Ankylosis of right hip	1
Cerebrospinal lues	2
No reason given	14
Stricture posterior urethra	1
Perineal operation abandoned, urethra torn	2
Suspected malignancy of bladder	3
Perirectal inflammation	1
Rectoperineal fistula	1
Total	108

The *operation* was done in one stage in 76 per cent. of the cases; in two stages in 24 per cent. Prostatectomy was complete in 81 per cent. of the cases, but in 19 per cent., either one lateral lobe remained or the middle lobe alone was removed. Several of these (9) were cases in which an incomplete prostatectomy had been done previously, and suprapubic operation was carried out to remove the remaining lobe.

Study of the *pathology* of the specimen removed showed glandular hypertrophy in 75 per cent., increased connective tissue in 45 per cent., muscular hypertrophy in 5 per cent., carcinoma in 10 per cent.

Convalescence.—Epididymitis occurred in 11 per cent. of all cases and phlebitis in 2 per cent. The closure of the fistula is known in 73 cases. It occurred within three weeks in 9, during the fourth week in 24, the fifth week in 3, the sixth week in 12, seventh week in 1, two months in 14, three months in 5, four months in 2. Nine patients died in the hospital following suprapubic prostatectomy. The cause of death was as follows: Pyonephrosis and uremia 1, diabetic coma 1, pneumonia 2, septicemia 1, hemorrhage 1, during operation 1, cancer of prostate 1, cause not stated 1. Hospital mortality in these 108 cases of suprapubic prostatectomy was, therefore, 8.2 per cent.

Ultimate Results.—Every effort has been made by questionnaires and letters to patients and doctors to determine the result obtained by the operation. Owing to the fact that many cases were operated upon ten, fifteen, and even twenty years ago, it has been difficult to obtain the desired information. The following statistics are based on reports from 55 patients:

TABLE 161

Results Obtained in 55 Cases of Suprapubic Prostatectomy

	Cases	Per cent.
Obstruction cured	42	75
90 per cent. improved	4	7
75 per cent. improved	5	9
50 per cent. improved	1	2
Frequency still present	25	45
Incontinence	3	5
Weak force	2	4
Hernia at site of operation	2	4
General result good	39	60
General result fair	12	22
General result poor	2	4

Only 11 of these cases were followed over five years.

OPERATIVE TREATMENT OF CANCER OF THE PROSTATE

Those cases of cancer of the prostate in which surgery is carried out may be briefly divided into three classes: (1) Those early enough for a radical operation; (2) those in which an operation is performed to insert radium with the prospects of cure; (3) those in which palliative operation is necessary to relieve obstruction, pain, or hemorrhage.

Radical Operation (Perineal).—In 1909 we[1] briefly summarized the history of operations for the radical cure of carcinoma of the prostate as follows:

> I have been able to find but 5 cases in the literature in which a radical operation has been performed for primary carcinoma of the prostate. In 3 cases the prostate was completely excised, but the seminal vesicles and the adjacent portion of the vesical trigone were not removed. Death resulted in all 3 cases, once from operative shock and twice from recurrence. One of these cases is interesting because the operation was performed as far back as 1882 by Leisrink. The second case was operated on in a similar manner by Czerny in 1889, with operative recovery.

[1] Young: Annals of Surgery, 1909, l, 1144–1233.

In 1898 Fuller performed the operation through a suprapubic wound, excising the prostate and a small portion of the anterior wall of the bladder. He found it impossible to suture the bladder to the membranous urethra, but after a tedious convalescence the suprapubic wound finally healed and urine passed through the urethra. The patient died eleven months later from recurrence. In 1891 Kuster performed a most extensive operation in which he freed the entire bladder through a suprapubic incision and then, through a perineal incision, divided the membranous urethra and the ureters at their vesical juncture and removed the bladder, the seminal vesicles, and the prostate in one piece. The ureters were then transplanted into the rectum. The patient lived five days after the operation. In the following year Harris did almost as extensive an operation, removing the prostate and all but the apex of the bladder through a suprapubic incision. The ureters were transplanted into the small vesical cap remaining of the vertex of the bladder, and the immense space left after the removal of the prostate and bladder was left to heal by granulation. The patient recovered from the operation and lived for two months. Autopsy showed that the space from which the prostate and bladder had been removed was almost completely lined by epithelium which connected the urethra with the remaining portion of the bladder. The right kidney was normal, and both ureters were patent. Numerous carcinomatous metastases were found.

In 5 cases of carcinoma involving the rectum and the prostate operators have attempted excision of both rectum and prostate, four patients died soon after the operation, but one, by Demarquay, operated upon in 1873, remained well after two years. In this case, however, very little of the prostate was removed, as the "urethra and ejaculatory ducts were respected."

At the time when the radical operation, which will be described further on, was first employed by me in 1904, I was not aware of any of the operations for carcinoma of the prostate which had been described in the literature. A careful study of them shows that in no case was the operation described by me carried out. A study of cases and of autopsies had convinced me that, in order to obtain a radical cure of carcinoma of the prostate, it would generally be necessary to remove not only the entire prostate with its capsule and urethra but also the seminal vesicles and the overlying portion of the vesical trigone, owing to the fact that the spread of the disease is nearly always into the tissues immediately beneath the trigone and around the base of the seminal vesicles. I therefore decided in 1904[1] to carry out the following procedure:

"*Radical Operation.*—Exposure of prostate through perineum as in operation for conservative perineal prostatectomy. Division of membranous urethra, mobilization of entire prostate with its capsule. Resection at the vesicoprostatic juncture, including a cuff of the bladder and two-thirds of the trigone, and complete removal of seminal vesicles and ampullæ in one piece with the prostate and vesical neck. Anastomosis of vesical wound with membranous urethra, closure of remainder of vesical wound posteriorly."

This technic was followed in 12 cases with excellent results, the one drawback being incontinence of urine, which was present in all cases. In 1910 we undertook a study to determine, if possible, the cause of the incontinence of urine. It was evident that the external sphincter had not been injured by the technic which we followed. In cases of suprapubic prostatectomy by the method of Freyer the internal sphincter remains dilated and the external sphincter alone is sufficient to furnish urinary control. What, therefore, was the cause of the incontinence? It seemed probable that it was due to division or injury of nerves or blood-vessels supplying the triangular ligament and region of external sphincter. A careful study of the anatomy showed that the anterior surface of the prostate was covered by a layer of fascia which separated it from the vessels and nerves of the space of Retzius as shown in Figs. 839 and 840.

Accordingly, examination was made at operation and it was found that, by blunt dissection, this fascia could be separated from the anterior surface of the prostate without difficulty and without opening into the prostate. There was also far less

[1] Young: The Early Diagnosis and Radical Cure of Carcinoma of the Prostate, Johns Hopkins Hospital Bulletin, 1905, xvi, 315–321.

hemorrhage than in operations by the previous technic, in which the lateral and pre-prostatic vessels were injured and with difficulty ligated.

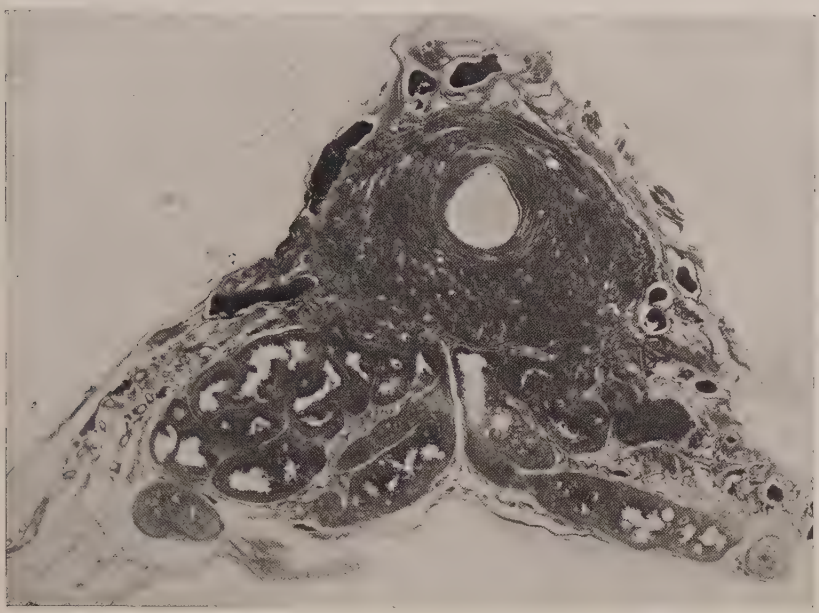


FIG. 839.—Low-power magnification of a horizontal section of the prostate and seminal vesicle. from a normal individual. The urethra is circular in form owing to the fact that the specimen was hardened with a catheter *in situ*. The fascial investments of the prostate and vesicles are well shown Also the relations between the prostate and the preprostatic venous plexus which must be avoided in the radical operation for removal of the prostate. From Mr. Henry Wade.

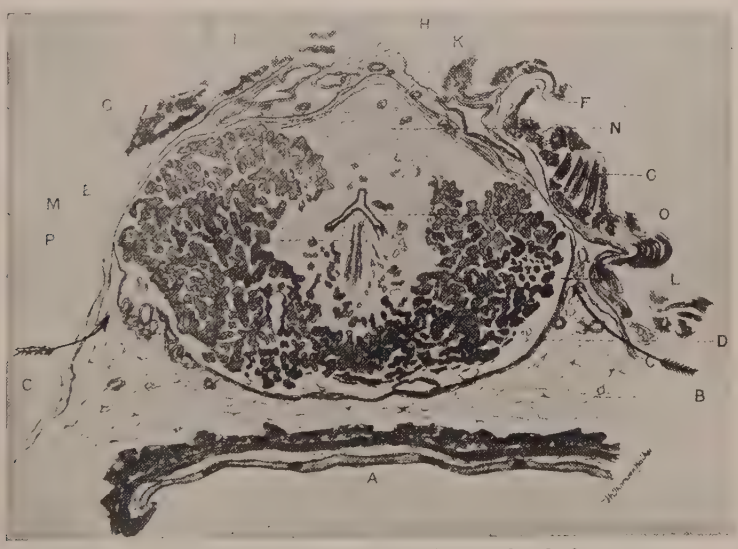


FIG. 840.—Transverse section of prostate and surroundings at level of verumontanum, the anterior surface of the prostate being shown uppermost. Arrows indicate the point at which the anterolateral fascia should be reflected from the prostate.

Since 1914 we have operated upon 15 cases by the new technic and in almost every case perfect urinary control has been obtained.

Description of Radical Operation.—An inverted U skin incision is made as in the operation for conservative perineal prostatectomy, but the lateral incisions are made about 1 inch longer (Fig. 842). The levator ani muscles are divided slightly on each side and the wound widely retracted so as to give an excellent exposure. Having arrived at the membranous urethra, the prostatic tractor is inserted as usual and the rectum is carefully freed from the posterior surface of the prostate and from the seminal vesicles above. Care is taken not to penetrate the anterior layer of Denonvilliers' fascia or to cut into the prostate or vesicles covered by it. The lateral margins of the prostate and vesicles are also freed by blunt dissection and a careful inspection made to see that the carcinoma has not extended too far for radical operation, that the upper portions at least of the seminal vesicles are free from invasion and that no glands are present along the pelvic wall on either side. By palpation and inspection, the correctness of the diagnosis is verified. In carcinoma of the prostate great induration is generally sufficient to warrant a positive diagnosis even though only a portion of the prostate is involved. If the operator is still

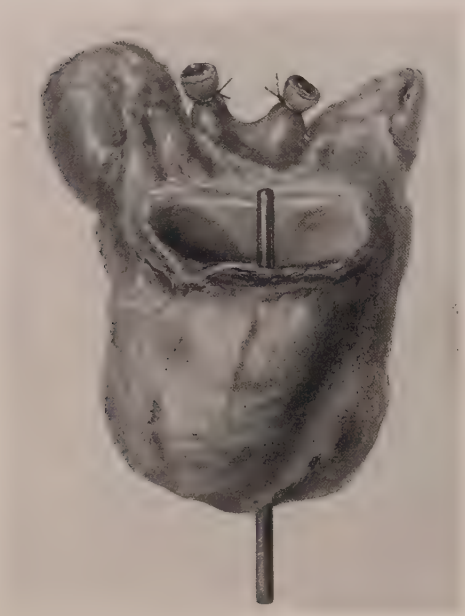


FIG. 841.—Radical operation for carcinoma of prostate. Anterior view of specimen showing removal of entire prostate with capsule, cuff of bladder, seminal vesicles, and vasa deferentia. B. U. I. 7539.

FIG. 842.—Perineal incision used for radical operation for carcinoma of prostate.

unable to make a positive diagnosis of carcinoma, a suspicious area along the posterior surface may be excised and examined. Care should be taken to prevent inoculation of the wound by immediately cauterizing the area and perhaps

FIG. 843.—Young's radical operation for the cure of carcinoma of the prostate. Sagittal section showing the manner in which the prostate and seminal vesicles are exposed. The dotted line indicates the structures which are removed in carrying out this operation and the planes which should be followed.

FIG. 844.—Young's radical operation for carcinoma of prostate. Separation of lateral and anterior surfaces of prostate from pelvic fascia.

closing with sutures through the capsule while the frozen section is being made and studied.

Having determined that the case is one for radical operation the next procedure is to search for the point along the lateral surface of the prostate where the fascia coming from the lateral wall of the pelvis divides to encircle the prostate. By making an incision through the posterior layer close to the prostate one can then by blunt dissection easily separate the anterior layer from the prostate on each side until the membranous urethra is reached, as shown in Fig. 844.

Making downward traction upon the prostatic tractor one divides the membranous urethra transversely at a point below the membranous urethrotomy wound, as shown in Fig. 845. Having thus freed the prostate from the membranous

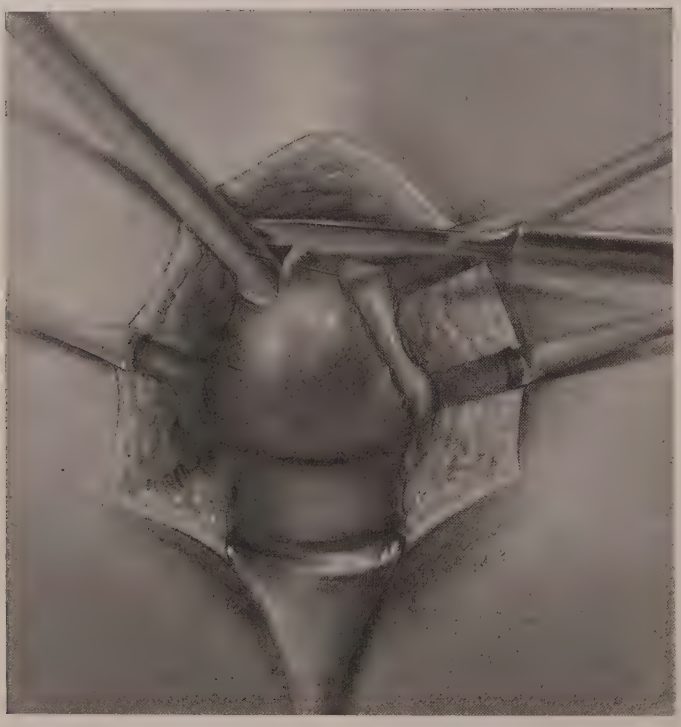


Fig. 845.—Radical prostatectomy: Transverse section of membranous urethra. Partial separation of lateral fascia from side of prostate is shown.

urethra, the blunt dissection is carried upward, pushing away the anterior layer of fascia, and freeing the prostate until the bladder is reached immediately above the vesicoprostatic juncture in the median line anteriorly (Fig. 845). A scalpel is then plunged into the bladder at this point, the wound enlarged on each side and a long retractor placed within the anterior wall of the bladder, so as to expose the interior, as shown in Fig. 847. The trigone, ureteral ridges, and orifices are then brought into view and with the scalpel a curved incision is made through the trigone, as shown in Fig. 847, the line passing within 1 cm. of the ureteral orifice on each side and dividing the muscles of the trigone and the vesical wall beneath it.

By blunt dissection the bladder is then pushed upward and the anterior surface of the seminal vesicles and vasa deferentia exposed. This process is continued

upward until the tip of the vesicle is reached on each side and the ampullæ isolated. The vasa deferentia above are picked up upon a curved clamp or hook on each

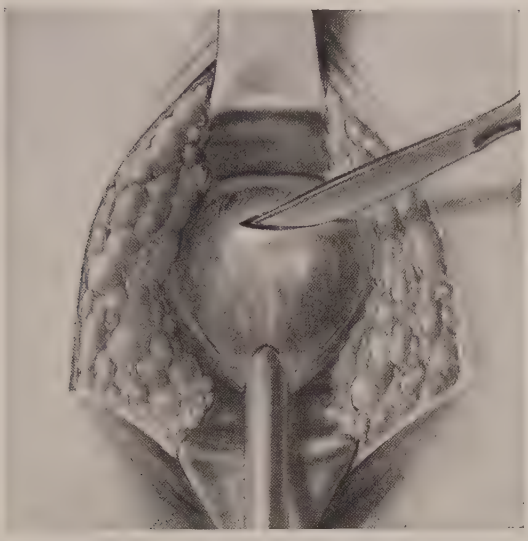


FIG. 846.—Radical prostatectomy: Anterior prostatic fascia drawn upward. Prostate, freed from urethra and anterior attachments, drawn downward, exposing bladder wall which is being incised transversely just above upper limits of prostate.

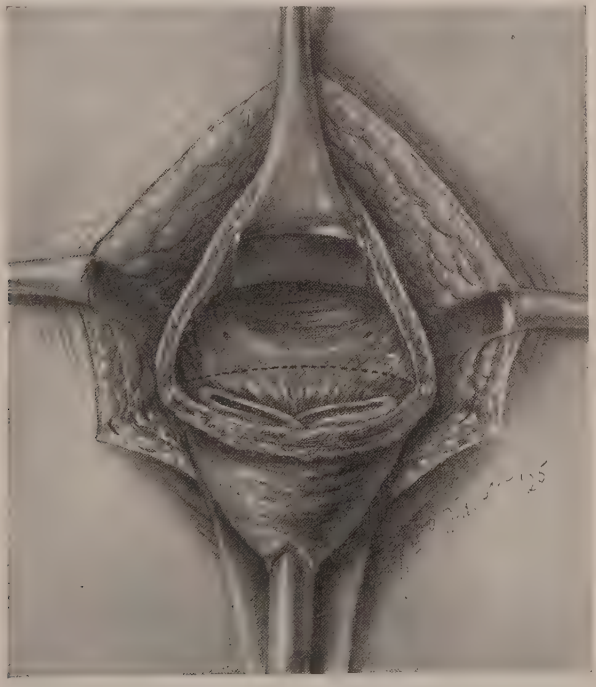


FIG. 847.—Radical prostatectomy: Bladder opened and retracted, exposing trigone. Dotted line shows site of incision 1 cm. below ureteral orifices.

side. The fibrous attachments of the upper portion of the vesicle are then cut, clamped, and ligated carefully, since, if this is neglected, there may be free bleed-

ing at this point. The vasa deferentia are clamped and divided and the entire prostate with its capsule, urethra, cuff of bladder, both seminal vesicles, and ampullæ are removed in one piece, as shown in Fig. 848. Careful inspection of the specimen should then be made to see that the tumor has been radically excised. If the tumor tissue is very close to the surface or adherent externally at any point, the wound should be carefully examined and radium inserted in this region if the operator fears that it has been invaded by carcinoma.

Anastomosis of Bladder to Urethra.—After removing the entire prostate, as above described, there remains a very large open wound in the bladder which must be brought down and anastomosed with the membranous urethra. It is usually possible by traction with clamps to suture the remaining anterior part of the vesical

FIG. 848.—Radical prostatectomy: Freeing of seminal vesicles and vasa, which are shown ligated on right side. Opened bladder and ureters retracted upward.

wall to the stump of the membranous urethra, as shown in Fig. 849. Heavy chromic catgut is used, the suture being so placed as to include mucous membrane, and tied externally. The boomerang needle-holder (Fig. 787) is of great assistance in placing these sutures which are inserted alternately on each side until the entire circumference of the urethra has been approximated to the bladder wall (the anastomosis being completed by a figure-of-8 stitch in the median line posteriorly). Eight or ten sutures are generally necessary to make this anastomosis satisfactorily. They should be placed deeply through adjacent muscular structures and tied not too tightly. During this procedure, a urethral catheter remains within the point of anatomosis and projects into the bladder, where it remains for drainage after operation. The rest of the bladder opening is closed (posteriorly) by a con-

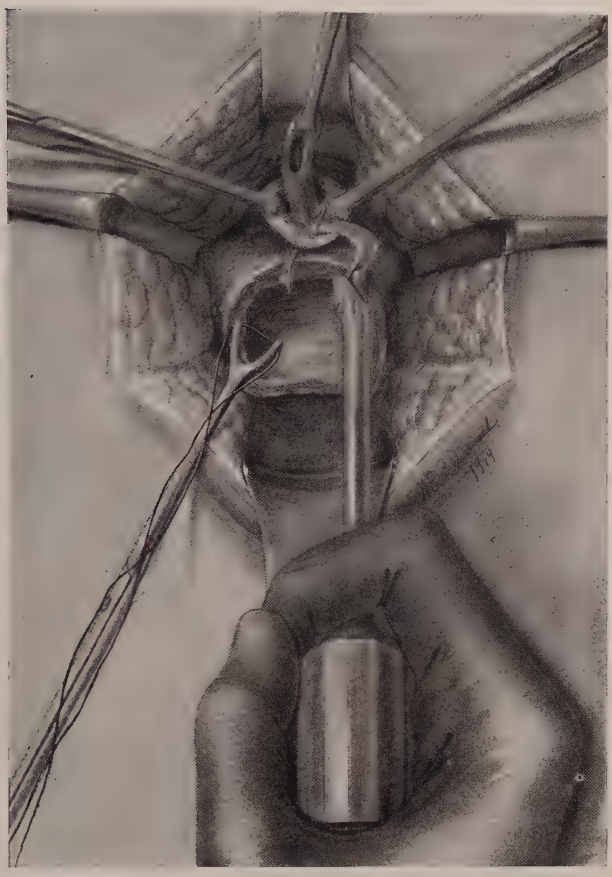


FIG. 849.—Radical prostatectomy: Anastomosis of anterior wall of bladder with membranous urethra by means of boomerang needle-holder and suture carrier.

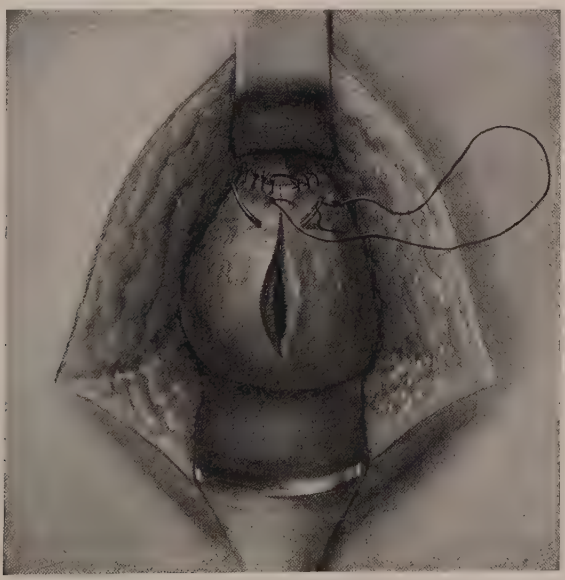


FIG. 850.—Radical operation for carcinoma of prostate: Final closure of bladder after anastomosis with stump of membranous urethra. Continuous chromic catgut.

tinuous chromic catgut suture, which does not include the mucous membrane, as shown in Fig. 850. The completed suture is shown in Fig. 851.

In only 1 case have we been unable to carry out the anastomosis as above described. Recently we found the bladder so adherent that it was impossible to draw down the anterior wall to the membranous urethra. We, therefore, had to close a portion of the defect anteriorly in the median line with a continuous chromic catgut stitch and then to anastomose the lateral margins of the vesical opening with the membranous urethra. This left only a small area to be closed by a posterior longitudinal line of sutures. In this case, however, the anastomosis was entirely satis-

Fig. 851.—Radical operation for carcinoma of the prostate: Longitudinal section showing result after closure of the bladder and completion of the vesico-urethral anastomosis. A catheter is in place in the urethra.

factory. For about ten days after operation there was no leakage whatever through the perineum and soon thereafter it closed permanently.

Hemorrhage should be completely arrested by careful ligature of all bleeding points, special attention being given during the operation to the depths of the wound on each side, lest a blood-vessel retract and bleed retroperitoneally. This occurred in one of our cases and very troublesome postoperative hemorrhage ensued.

After drawing the levator muscles together with a chromic catgut suture, the wound is closed with gauze drainage. The urethral catheter is left in place to drain the bladder, and is fastened to the penis as usual with adhesive plaster.

Two operative specimens removed in the above manner are shown in Figs. 852 and 853.

Postoperative Treatment Following Radical Operation for Carcinoma of the

Prostate.—The treatment of these cases is very similar to that employed after perineal prostatectomy in benign cases. The usual infusion of 1500 c.c. salt solution beneath the breast is given. If there is marked shock, appropriate measures are taken, including blood transfusion, if necessary. This has only been employed in 2 cases. Gauze packing has usually not been necessary, but in one instance, where hemorrhage was pronounced, packing of the wound after operation was required. In another case in which a similar operation was carried out where tuberculosis of the prostate was present, a small artery above the left seminal vesicle began to bleed soon after the operation and, although the wound was vigorously repacked, the patient died. Autopsy showed that the bleeding traveled upward behind the peritoneum and reached the region of the kidneys. This case showed the great importance of careful hemostasis at operation. As a rule, only one to two small rubber drainage-tubes leading to the retrovesical wound are used, and these are generally removed within four or five days. The urethral catheter remains *in situ* generally for eight or ten

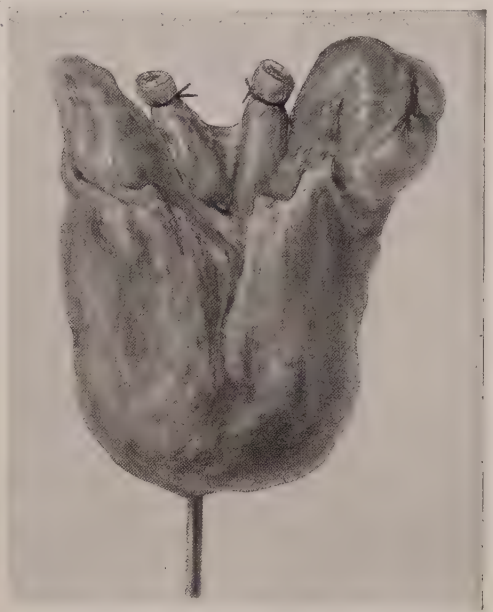


FIG. 852.—Radical operation for carcinoma of prostate: Posterior view of prostate, seminal vesicles, and ampullæ. B. U. I. 7539.

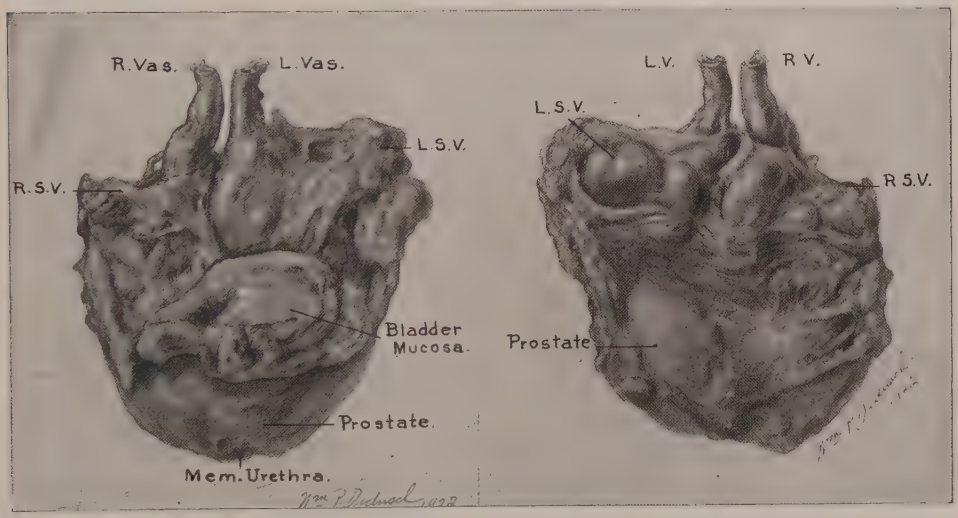


FIG. 853.—Anterior and posterior view of specimen of carcinoma of prostate and seminal vesicles removed by radical operation. Note bladder mucosa removed with vesical neck and trigone. B. U. I. 10,043.

days. During this time the urethra is carefully examined every day to see that there is no periurethral infection. In 1 case an abscess occurred around the

catheter in the bulbous urethra and before it was recognized the patient developed septicemia from which he died. The perineal wound usually closes with remarkable rapidity, often more quickly than after a simple perineal prostatectomy. Urethral dilatations are practically never required and we do not know of a case in which stricture followed this operation. If cystitis is present, it is treated either by water in large amounts or by internal antisepsis.

The ultimate results have been remarkably good and during the past ten years practically every case has had almost normal urination with good control. The results have been studied in detail. (See Vol I, page 653.)

Variation; Subtotal Prostatectomy.—In several cases in which the carcinoma seemed to be localized to one lobe of the prostate, we have carried out a subtotal prostatectomy as follows: The involved lateral lobe with its capsule and adjacent urethra and the seminal vesicle were removed in one piece, the line of resection being well away from the evident limits of the carcinomatous invasion. In some of these cases only a strip of urethral mucous membrane remained between the external sphincter and the bladder, and the seminal vesicle and ampulla were stripped away from the posterior wall of the bladder. Geraghty has applied a similar procedure to both sides of the prostate. After freeing the lateral lobes and urethra from the anterior capsule up to the bladder and dividing the urethra he has stripped the prostate and vesicles from the vesical neck and trigone.

It is our opinion now that a complete radical operation is preferable to either of these two procedures because of the greater certainty of completely removing the carcinomatous invasion. Since the introduction of the newer technic by which complete urinary control is effected, there is no reason to preserve the vesical sphincter and, as a matter of fact, the ultimate result is better, as shown by one of the cases in which subtotal prostatectomy was carried out. A persistent stricture followed, whereas, after the radical operation, none of the patients has suffered from a stricture at the point of anastomosis.

Palliative Operation to Relieve Obstruction (Perineal).—*Perineal prostatectomy for cancer of the prostate not suitable for radical operation and without hypertrophy, but with obstruction.*

The group of cases which we wish to describe here are those in which the disease has progressed too far for radical operation, or the extreme age of the patient, or his weakened condition precludes a radical operation. They are cases also in which obstruction to urination of considerable degree is present and in which the *x*-ray shows no evidence of metastases and no carcinomatous glands are palpable either by rectum, groin, or elsewhere.

These cases are, therefore, those in which there may be a possibility of a cure by the use of radium. In many cases of this type radium has been applied through rectum, urethra, and bladder, to the areas involved in the carcinoma, according to the technic described elsewhere (Vol. I, page 644). It is presumed that radium treatment has been tried and the patients still have either complete retention of urine or marked difficulty and frequency of urination, requiring catheterization or very frequent voiding. Our object should be to remove the obstruction to urination and at the same time take all necessary measures to effect a cure, if possible.

Exposure of the prostate may be carried out by the same technic that we have

proposed in seminal vesiculectomy[1] (page 515). A special long urethral prostatic tractor is introduced first into the membranous urethra, but not into the bladder, until the apex of the prostate is exposed through the perineum bythe technic usually employed in perineal prostatectomy. The instrument is then carried onward into the bladder, opened, and traction made, thus drawing the prostate down toward the perineum while the operator pushes backward the posterior layer of Denonvilliers' fascia with the levators and rectum. In this way the whole posterior surface of the prostate is brought well into view. An incision is made parallel to the urethra on each side through the posterior capsule and into the prostatic substance for a distance of perhaps 1 cm., the two lines of incision being about 2 cm. apart. These incisions avoid the urethra and the ejaculatory ducts and open the capsule for the enucleation of the lateral prostatic lobes. This can now be done without much difficulty by means of blunt and sharp dissection within the capsule. For this purpose a large sharp curette is used in enucleating the deeper portion beneath the vesical neck. This procedure is carried out on the opposite side so that the lateral cavities are now empty and the urethra well intact with a small amount of prostatic tissue adherent to it along the line of incision on each side.

The median portion of the prostate remains to be removed and this can be done best through one of the lateral cavities. We usually use a sharp hook to pick up the prespermatic portion of the prostate and start the excision below with a scalpel, finishing the upper subcervical excision of the median mass with the sharp curette. In so doing a tunnel is made from one cavity to the other in front of the ejaculatory ducts and beneath the floor of the vesical neck and posterior urethra.

In some cases it is possible to remove the median portion without injury to the mucous membrane, but generally a tear is made and through this the finger should now be inserted to examine the vesical neck for contracture of the prostatic orifice (tight sphincter), or for any remaining enlargement in the median portion or lateral portions, also for subtrigonal infiltrations and enlargements. If the sphincter will not admit the finger, it may be dilated with a glove stretcher or by removing the bar with our "punch," after which the finger may readily be introduced.

Palpation will indicate whether there remains any enlargement or carcinomatous mass in the median or subtrigonal portion and if so these are scraped out from beneath with a curette while the index-finger of the left hand remains inserted to force the tissues outward, acting as a tractor to facilitate the enucleation. The finger can likewise be used for any remaining lateral enlargement. If the median enlargement is still considerable, a spoon tractor may be conveniently employed for this purpose.

The operator having assured himself that the lateral and median masses of carcinoma and all obstruction at the prostatic orifice or beneath the trigone have been removed with as little injury to the vesical neck, sphincter, and trigonal mucosa as possible, the next step is to introduce radium in sufficient quantity, if possible, to cure the patient. This may be done in various ways.

(*a*) *With Needles of Radium Emanation.*—We have usually employed tubes (glass) each containing 1 millicurie of radium emanation. With this dosage it is

[1] Young: Perineal Method for Excision and Draining the Vesicles, Transaction of the American Association of Genito-Urinary Surgeons, 1912; Journal of American Medical Association, 1913, lxi, 822–825; also Surgery, Gynecology, and Obstetrics, April, 1918, 375–384.

necessary, in order to secure proper therapeutic effect, to implant one seed to each cubic centimeter of tissue. As it is usually desirable to implant radium into the seminal vesicles and tissues between and around them, it is wise to insert a short prostatic tractor through one of the lateral cavities into the bladder upon which traction is made, while the seminal vesicles are exposed by blunt dissection, until normal tissues well beyond the areas of infiltration are reached with the finger or reachable with the radium needles. Radium is then inserted by means of appropriate needles supplied with plungers to the proper depth and at correct distances, so that one seed containing 1 millicurie of radium emanation is *in situ* for each cubic centimeter for the entire area to be treated. This will usually require about four or more tubes for the area of each seminal vesicle, two between them, at the upper limit of the prostate, several in the median suburethral portion of the prostate, and several in each of the lateral portions as well as in the anterior commissure. From twenty to thirty tubes are thus required to supply the portions above mentioned and the tissues around the vesical orifice and trigone. If the disease has progressed further in one direction than another, that region is more vigorously attacked than the opposite side. Where the prostate is markedly adherent anteriorly it may be desirable to insert radium seeds into the preprostatic tissue and the same is true for other regions of the prostate and also for the seminal vesicles.

These seeds, once introduced, remain in place. Specimens which we have obtained later at autopsy show that each is surrounded by a zone of fibrosis, resulting from necrosis and that further away an area of cell destruction, extending more than $\frac{1}{2}$ cm., is usually present. The emanation seeds of larger content than 1 millicurie are not to be used on account of the severe necrosis which they produce and, as remarked elsewhere, the penetration obtained is very little greater than that obtained with seeds of 1 millicurie each. Where smaller doses are used one must employ a correspondingly greater number of seeds, so that the area is fully covered by the dosage of 1 millicurie per centimeter. If, therefore, $\frac{1}{2}$ millicurie seeds are used they must be placed so that we have a $\frac{1}{2}$ millicurie seed in each cube 0.8 centimeter in dimension.

(*b*) *The Use of Screened Radium, either Element or Emanations.*—There are many who prefer to use the radium screened, either in the form of element or needles, so as to avoid the necrosis immediately around the radium produced by the alpha- and beta-rays, if unscreened. If surrounded by a metal needle or other container, it is naturally necessary to remove it later. For this purpose we have small needles containing radium element, 1 milligram each, provided with a small eye in which a strong linen thread is placed and used to pull them out later. These radium points are inserted by means of a special instrument with a wire plunger which pushes the radium out of the holder into the tissues. They are introduced carefully into the tissues so as to cover, as nearly as possible, the entire area at the dosage of 1 millgram per cubic centimeter of tissue. The same care is taken to introduce these needles well above the prostate into the region of both seminal vesicles and the intervesicular space. The threads which are attached to the platinum points containing the radium are held together with a ligature and brought out along with the rubber drainage-tube which has been inserted through one lateral cavity into the bladder to carry off the urine. Hemorrhage is usually so slight in these cases that packing is unnecessary. If vigorous

bleeding is encountered, it may easily be arrested by ligatures and sutures in the deeper portions or by the Davis drainage bag.

(*c*) *With Larger Amounts of Radium.*—At times the only radium available in our clinic has been tubes containing 10, $12\frac{1}{2}$, and 100 mg. each. The smaller doses are in the form of needles and are inserted into the various portions of the prostate. The handles of the needles are tied together, and brought out along with the drainage-tube through the wound and fastened to the skin outside. The capsules of 100 mg., each surrounded by additional filters, one of platinum, the other of gold, are inserted into thin rubber tubes which are then ligated on each side of the radium container and inserted into one of the prostatic cavities or into the vesical neck. Not infrequently we have employed two capsules of 100 mg. each, two needles of $12\frac{1}{2}$ mg. each, and four needles of 10 mg. each, in addition to twenty needles containing 1 mg. each. In such cases the 100 mg. capsules are generally withdrawn in six hours, thus giving 1200 milligram hours, the two $12\frac{1}{2}$ mg. needles withdrawn in twelve hours, giving 300 milligram hours, the four 10 mg. needles allowed to stay fifteen hours, totalling 600 milligram hours, and twenty needles of 1 mg. each removed in thirty-six hours, giving 720 milligram hours, a total of 2800 milligram hours.

When this large dosage of radium is left in the region of the prostate, seminal vesicles, and adjacent tissues, it is important to screen the rectum very carefully so as to avoid ulceration and fistula. It is therefore desirable to use a piece of lead foil behind the region in which the radium has been placed and surround it by gauze and rubber protective, the whole to be withdrawn after the last radium is pulled out. The simple use of a gauze pack, even though large, to protect the rectum is not sufficient as we have found to our sorrow, having had 2 cases of rectal breakdown as a result of using these implantations.

The subsequent treatment of these cases does not differ materially from that of hypertrophy of the prostate in which perineal operation has been done. The rubber drainage-tube is removed in forty-eight hours, after which the urine escapes from the perineum until the fistula finally closes and normal urination is established. It may be necessary to pass a urethral sound in order to keep the bulbomembranous urethra open. The use of large amounts of water, antiseptics, and other treatment is the same as detailed elsewhere for benign cases.

Perineal Prostatectomy for Cancer with Hypertrophied Lobes and Not Suitable for Radical Operation.—The carcinoma is usually found to form a layer posterior to the benign adenomas in the lateral regions. If the diagnosis has been made from the induration and the suburethral thickening, the appropriate radium treatment by rectum, urethra, and bladder is usually undertaken with radium element properly screened as described elsewhere. This treatment having been employed and the patient still having complete retention, or considerable difficulty and frequency of urination, perineal prostatectomy is undertaken to remove the obstruction. With bilateral capsular incisions which pass through the posterior lamella of carcinomatous tissue, the hypertrophied lateral lobes are reached and enucleated with ease. The median lobe, if present, is enucleated from one of the lateral cavities and a finger is inserted into the bladder to determine whether any hypertrophied lobes remain or to detect the presence of carcinoma of the vesical neck in the median portion of the prostate and beneath the trigone. If contracture of vesical orifice or carcinomatous masses are thus demonstrated, they are removed

by means of the curette. The vesical orifice having been sufficiently enlarged, radium is then implanted into the region of the prostate, seminal vesicles, and adjacent tissues with the assistance of the tractor in the bladder to draw down the region to be attacked, as described above.

An inverted V capsular incision may also be employed. When this is done the scalpel opens up the urethra, which is then divided on each side until the median lobe is reached, and then divided transversely in front of the median lobe. The adenomatous hypertrophy is then removed in one mass from in front of the carcinomatous posterior lamella. We have employed this method in numerous cases. It provides a better enucleation of the adenomatous hypertrophy, but has the disadvantage that the prostatic urethra is much more extensively lacerated and removed and the healing is not so satisfactory nor so rapid.

It is a remarkable fact, shown by these operations, that even though the mucosa is lacerated or destroyed to a considerable extent, the urethra re-forms and covers the defect, growing over the remaining carcinomatous tissue. This reproduction or re-formation of mucous membrane over the carcinomatous tissue is one of the most remarkable pathologic facts in connection with prostatic carcinoma. The subsequent treatment is practically identical with that for benign prostatic hypertrophy. The results obtained have been remarkably satisfactory and our experience now confirms our original statements made when this procedure of conservative operation for cancer of the prostate was first promulgated in 1907.[1]

OPERATIVE TREATMENT OF PROSTATIC ABSCESS

Unilateral Operation.—Where the prostatic abscess is limited to one of the lobes of the prostate, it may be reached conveniently by the following technic: A sound is passed into the prostatic urethra for the guidance of the finger, so that the urethra may be avoided. In some cases we have used our long urethral prostatic tractor which is passed into the bladder and traction made so as to bring the prostate nearer to the perineum. In other cases, we have operated without the insertion of any instrument, which is unnecessary when the abscess is fairly large. Oblique incision, corresponding to one branch of the inverted V incision used for perineal prostatectomy, starting in the median line and extending backward and outward for distance of about 4 to 6 cm.; division of fat and fascia; insertion of finger to open up the space bounded by the transversus perinei and triangular ligament in front, the central tendon and recto-urethralis internally, and the levator ani posteriorly. This blunt dissection will bring the operator down upon the external border of the apex of the prostate on that side. If a fluctuating abscess is felt, it may be broken into or incised without the insertion of retractors or actual observation of the prostate. If it is desirable to view the prostate narrow bladed retractors are inserted laterally and posteriorly and the apex of the prostate exposed. The posterior layer of Denonvilliers' fascia is divided and pushed backward, along with the levator muscle, thus exposing the posterior surface of the prostate on this side.

If it is desirable, the entire posterior surface of the prostate may be thus exposed, and in fact we have enucleated an adenomatous hypertrophy by this method. After exposing the prostate an incision is made so as freely to evacuate the ab-

[1] Young: Transactions of the American Association of Genito-Urinary Surgeons, 1907, ii, 78–84.

scess. Effort is made to avoid the urethra so as to have no urinary fistula. The abscess cavity is washed out with antiseptic solution, and either cigarette drains or very soft rubber tube drainage provided. The skin incision is partly closed around the drains, which are maintained in place for six or eight days, so as to provide a sinus through which the abscess cavity can be completely evacuated until closed from the bottom.

Bilateral Operation: (*a*) *Without Division of the Recto-urethralis Muscle.*—By this method the operation is carried out as follows: Inverted U cutaneous incision, with division of fat and fascia, and opening up of the space on each side of the central tendon by blunt dissection. The bifid tractor is inserted, the central tendon divided, and the recto-urethralis muscle exposed but not divided. The apex of the prostate on each side of the central tendon is then exposed with the proper traction and blunt dissection. The posterior layer of Denonvilliers' fascia is then divided on each side and pushed backward with the levator muscle, exposing at first the apex, and then the posterior surface of the prostate. This technic is repeated on the opposite side, so that the lateral lobes on each side are well exposed and the operation may be carried out with any incision that is necessary to reach the abscess, and to avoid opening the urethra. A longitudinal incision is generally preferred and should be for the entire length of the prostate. Drainage and subsequent treatment as above described.

(*b*) *With Division of Recto-urethralis Muscle and Complete Exposure of the Posterior Surface of the Prostate.* The technic is the same as that described under (*a*) except that the recto-urethralis muscle is divided, and, after division of the posterior layer of Denonvilliers' fascia, the rectum is pushed backward with the levator muscles and Denonvilliers' fascia, thus giving a wide exposure of the posterior surface of the prostate, as for perineal prostatectomy. If previous examination has shown an abscess of one or both seminal vesicles, the fascia of Denonvilliers is pushed backward until these are exposed to view by deep traction posteriorly and on each side. After an investigation the operator may carry out the necessary incisions in both vesicles and prostate, and introduce adequate tubes or cigarette drains. The levator ani muscle should be approximated with chromicized catgut and the drainage brought out at each of the angles of the wound, which is closed in front with a deep mattress-suture of catgut and clips of metal for the skin. Here again the tube should be carefully fastened and kept in place for at least one week or ten days so as to provide adequate drainage and to form a sinus which will last until the wound has healed from the bottom and the suppurative process in the vesicles and prostate eliminated. Daily irrigations with mild antiseptic solution (meroxyl, 1 : 2000; mercurochrome, 1 : 200; nitrate of silver, 1 : 1000) may be used with advantage.

Intra-urethral Methods.—Some have advised the intentional rupture of the abscess by means of a sound or other instrument passed into the posterior urethra. Where the abscess is well advanced and the urethra thin little difficulty is experienced in doing this; in fact, not infrequently, the abscess breaks into the urethra and evacuates spontaneously. In some instances the cure obtained in this way is very satisfactory; in others it leads to continued suppuration of the prostate into the urethra and bladder, and may eventually form a pocket or pouch which does not heal. We have never employed this method. The abscess may also be ruptured through a urethroscope or by means of a suprapubic operation, the finger or

an instrument being inserted into the urethra to evacuate the abscess. This latter method, which has been recommended in the literature, would seem to us an entirely unjustifiable method of attack, particularly if there is a possibility of the process being tuberculous.

Postoperative Treatment.—In many cases the urethra is found open at operation, or occasionally it is unintentionally torn into. In most cases, however, we have been able, although the walls of the urethra have been very thin, to preserve its integrity, and these cases have healed generally without the formation of a urinary fistula or the escape of urine during urination. When this does occur, complete closure of the fistula eventually follows in most cases. The outer portion of the fistula should be kept open or a drainage-tube inserted into the deeper portion. Unless this is done accumulations of pus may form behind the outer closed portion of the wound and require further operation.

Results.—The records of the Brady Urological Institute show 22 cases of prostatic abscess which have come to operation. Two of these were tuberculous, with pulmonary involvement, and both ended fatally. In the remaining 20 cases there were 5 who died, 1 of staphylococcus septicemia, 1 of streptococcus septicemia, 1 of pyelonephritis, and 2 of multiple abscess, associated with diabetes. All of these cases were badly complicated ones, generally with stricture and severe urinary infection. Fifteen patients left the hospital well and with no urinary fistula. Most of the results obtained in these cases have been entirely satisfactory. The high mortality (25 per cent.) is due to the long neglect, the marked complications, and the character of some of these cases on admission. It shows the importance of considering local infections of the lower urinary tract as affairs of grave prognosis, and of providing for early evacuation of abscesses, either prostatic or peri-urethral.

It seems unnecessary to remark that complications, such as stricture of the urethra, peri-urethral abscess, and infiltration of urine should receive vigorous operative attention. If extravasation within the pelvis has occurred, or the abscess has progressed beyond the confines of the prostate, it may be necessary to make suprapubic incisions, median and lateral, for drainage and to follow the line of extravasation upward extraperitoneally with sufficient points of exit for good drainage. Suprapubic vesical drainage is also indicated.

OPERATIVE TREATMENT OF PROSTATIC CALCULI

The operation to be chosen depends upon the location, size, multiplicity, and the character of the calculus or calculi present, and the complicating conditions. The ancient operation of lateral lithotomy, upon a grooved staff, may be carried out successfully for the removal of a prostatic calculus, and if the incision is made posterior to the triangular ligament and external sphincter and not carried into the bladder, the sphincters may be avoided and the stone removed with ease and despatch.

Removal of prostatic calculi may be done by modern methods with greater exactitude as follows:

A. *Lateral Lithotomy with the Long "Urethral" Prostatic Tractor.*—The long prostatectomy tractor is inserted into the deep urethra and an oblique incision made, beginning in the median line at a point about 5 cm. in front of the anus and directed obliquely backward like one of the branches of the incision for prostatic

hypertrophy. The space external to the central tendon, in front of the levator ani and behind the transversus perinei muscle and triangular ligament, is exposed by blunt dissection and the fascia of Denonvilliers divided at the apex of the prostate. The posterior layer of Denonvilliers' fascia is then pushed back with the levator muscle and the rectum, thus exposing one-half of the posterior surface of the prostate. If the stone is embedded in the substance of the prostate on that side, an incision may be made upon it and the stone removed, sometimes without opening the prostatic urethra. Careful search, however, must be made for additional calculi, which are generally present and frequently embedded between the periurethral and the outer portions of the prostate.

Previous *x*-ray examination may be of great assistance in determining the presence of such calculi, but the operator should not cease until thorough investigation has been made and all have been removed. Such cases are usually associated with definite hypertrophy of the lateral and median portions of the prostate, and if so,

FIG. 854.—Operation for prostatic calculi: The prostate is exposed as in perineal prostatectomy. Lateral capsular incisions are made. The calculi are usually found in the layer between the lateral lobes and the posterior lamella, and may be removed by a curet as shown.

these should be removed, but if such is the case, a typical exposure, as for prostatectomy, is preferable to the technic above described.

The stone having been removed, the cavity may be packed with gauze, or if the urethra has been opened, tube drainage provided, the skin being closed around it. In 1906 we[1] proposed the following two methods (B and C):

B. *Perineal Lithotomy with the Aid of the Prostatic Tractor.*—Exposure of the membranous urethra as for perineal prostatectomy, insertion of prostatic tractor into the bladder. Incision of the prostate on the side containing the calculus, which, if intra-urethral, should include the urethra and be sufficiently long for the extraction of the calculus. If calculi are present in the bladder, the vesical orifice should be dilated or possibly divided, the stone forceps introduced, and the calculi removed. Drainage and closure as for perineal prostatectomy.

C. *Perineal Lithotomy Upon a Lateral Lithotomy Staff.*—Exposure of the membranous urethra and apex of the prostate as described above. Incision into the

[1] Young: Modern Methods for Performance of Perineal Lithotomy, Johns Hopkins Hospital Reports, 1906, xiii, 385–399.

membranous and prostatic urethra upon the lateral lithotomy staff, the knife being carried into the bladder if vesical calculi are also present. Removal of calculi with forceps.

D. *Perineal Prostatectomy.*—Where multiple calculi are present in the substance of the prostate it is generally best to remove the lateral and median portions of the prostate, which in most cases are slightly hypertrophied. In such cases the technic which we prefer is the exposure of the prostate as for perineal prostatectomy, bilateral incisions (Fig. 854) with careful scooping out of seed calculi, which are generally found between the hypertrophied central portion of the prostate and the peripheral non-hypertrophied layer of prostatic tissue. These small calculi are also found embedded in or around the median portion of the prostate. Their removal should usually be followed by enucleation of the middle lobe as shown in Fig. 855. Careful search of the bladder should be made to be sure that no calculi have slipped back into the vesical cavity and the vesical sphincter should be carefully pal-

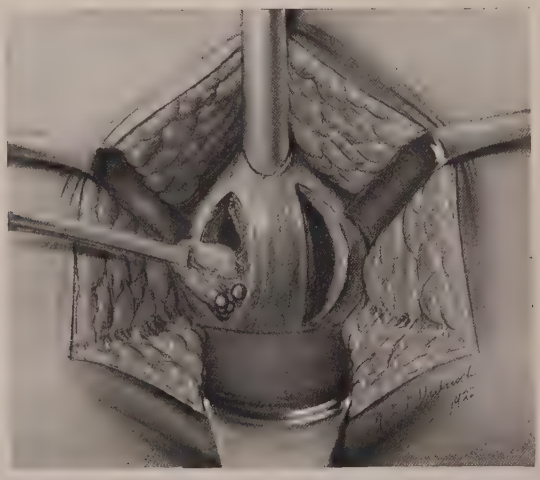


Fig. 855.—Operation for prostatic calculi: The hypertrophied lateral portions of the prostate may be removed through the capsular incision and the median lobe then enucleated as shown. More calculi may be found beneath it. It is also possible to use the inverted V capsular incision in this operation.

pated for contracture or bar before insertion of a tube for drainage and light packing of the lateral cavities or the Davis drainage bag. The final closure is that of perineal prostatectomy.

Results.—In our first report 4 cases were cited, 1 case of vesical calculus of moderate size which was removed through the perineum by method B, and 3 cases of prostatic stones, one of which was very large and projected into the bladder. It was removed by method C. In this paper we proposed these modern methods of "perineal lithotomy" in place of the ancient blind lateral lithotomy, not only for prostatic but for vesical calculi. We also showed that perineal lithotomy was much safer than suprapubic lithotomy for calculi of moderate size, especially when associated with prostatic hypertrophy. Our conclusions were as follows:

All large series of statistics show conclusively that in patients under fifty years of age (and not suffering with prostatic hypertrophy, or calculi incarcerated in diverticula), the operation of lateral perineal lithotomy is attended with far less mortality than the suprapubic route,

and if we are to judge by the statistics of Barling (who himself employed litholapaxy), lateral perineal lithotomy is distinctly safer than litholapaxy (2.5 per cent. as compared with 5.8 per cent.).

The objections to perineal lithotomy which have virtually caused its abandonment by surgeons have been that the operator could not see what he was doing, that the incision occasionally went into the rectum, that the space afforded was insufficient for the removal of very large calculi, and that the division of the external sphincter occasionally resulted in incontinence.

The advantages claimed for the open methods described above are that the operator can see what he is doing, that the external sphincter is preserved, thus avoiding incontinence, that a large space is afforded in which the urethra can be opened under visual direction, thus avoiding injury of the rectum and furnishing sufficient space for removal of even very large calculi with an attendant division of only two insignificant structures in the median line, that the urethral wound can be repaired by sutures, thus restoring normal urination immediately after the operation, that the convalescence is remarkably rapid, the functional result quickly established, and the mortality almost nil.

PUNCH OPERATION

History.—The punch operation came from the following case:

T. B. L., B. U. I. 1997, aged sixty-eight, admitted October 19, 1908, complaining of a catheter life. He gave no history of venereal disease. About twenty years ago, at the age of forty-eight, he began to have frequency of urination which slowly grew worse until he was voiding every hour, night and day. Three weeks ago retention of urine became complete and since then he has used the catheter twice daily. He now removes about 2000 c.c. daily and voids naturally about 500 c.c. His general health is excellent and he has no other symptoms.

General physical examination negative except for prostate and bladder. Prostate was normal in size, smooth, elastic, not tender, and no nodules. Seminal vesicles very slightly indurated and adherent; rectum negative. Prostatic secretion composed almost exclusively of pus cells and a few epithelial cells. No lecithin bodies seen. Urine cloudy with albumin, pus cells, and bacteria.

Cystoscopy.—Catheter finds about 500 c.c. residual urine. Bladder capacity 780 c.c. Tonicity impaired. Urethral length only 5½ inches when no traction is made upon penis. Cystoscope enters easily. No stricture present. Study of prostatic orifice shows slightly irregular margin. The anterior and lateral portions of the prostate are not enlarged. The median portion is definitely elevated in the shape of a slightly irregular transverse bar. There are no sulci present. A portion of the trigone is obscured behind the prostatic bar. The ureteral ridges and ligamentum interuretericum are no more elevated than normal. The ureters are negative and fluid ejected is clear. No trabeculation of the bladder. Slight cystitis. With finger in rectum and cystoscope in urethra there is slight increase in the median portion of the prostate. Lateral lobes do not seem much enlarged. Patient is advised to continue use of catheter four times a day so as to reduce the size of the bladder and to improve tonicity, and to return in a month.

January 26, 1909: Patient returns and states that he has been catheterizing himself four times a day, removing about 500 c.c. each time. Cystoscope again shows very slightly rounded median prostatic bar which extends a short distance over the anterior part of the trigone. Patient is sent into hospital for operation.

January 27, 1909: Operation, Young; ether. Suprapubic cystotomy and partial prostatectomy (excision of median portion of prostate). The bladder was exposed through a median incision and was found trabeculated and trigone slightly elevated. The median posterior portion of the prostate was found elevated in the form of a small projecting bar, but there was practically no intravesical enlargement. The lateral lobes of the prostate were negative. The prostatic orifice was tight and would not admit the finger. It was decided to excise the median bar and it was grasped with vulsellum forceps and a small V-shaped piece, the size of a pea, excised with scissors. The sphincter was partly cut and orifice was dilated to admit the forefinger. The bladder was then partially closed and a suprapubic drainage-tube provided.

The convalescence was slow, but without complications. On March 5th the patient started voiding through the urethra, 240 c.c. at a time, and had no incontinence. On March 8, 1909 he was discharged, voiding urine at normal intervals. There was no residual urine, the wound was healed, and his general condition was excellent.

April 10, 1909: Soon after leaving the hospital the suprapubic wound broke down. The patient was given a catheter to use and the posterior urethra was dilated with the Kollmann dilator on several occasions. After this the suprapubic wound healed, and has remained so for the past two weeks. He is now voiding urine without a catheter at intervals of two hours.

April 22, 1909: The patient returns and says that urination again became difficult and finally the suprapubic wound broke down.

Sounds were passed and the patient was given a catheter to use, but the suprapubic fistula persisted, in a short time symptoms of uremia developed, and death occurred from uremia.

Deductions.—The poor result obtained in this case caused us to consider the problem of small prostatic bars anew. It was evident that operative attack from the bladder was not sufficient to remove the obstruction in the urethral aspect of the median bar. The amount of tissue removed at suprapubic operation was so small that it seemed ridiculous to have to perform suprapubic operation for this purpose. Shortly before this we had devised a curved posterior urethroscope (Fig. 872, A). It occurred to us that if a fenestra could be placed on the posterior surface of this urethroscopic tube, the median bar would drop into it when the instrument was passed into the urethra and that a cutting tube passed within the outer tube could remove the median bar more radically than it could be done from the bladder through a suprapubic wound as in the previous case. Accordingly, an instrument of this type was devised, using one of our posterior urethroscopic tubes (Fig. 872, B), the exterior diameter of which was 28 F. We provided a fenestra about 1.2 cm. long, after filling up the aperture near the inner end, and an inner cutting tube of steel. It was also fitted with an obturator, and externally carried a light-holder for urethroscopic observation (Fig. 872, B).

The first case upon which this instrument was used was as follows:

A. S., B. U. I. 2124, aged forty-eight, admitted March 29, 1909 complaining of pain in the neck of the bladder and difficulty in micturition. The patient had gonorrhea about twenty years ago and again ten years ago. Shortly after the first attack of gonorrhea he began to have a burning in the neck of the bladder. This has gradually become worse and urination has not been free. When he attempted to void he had to stand and wait before urine would flow, and then the stream was small. Nocturia every three hours. There is present almost constant burning at the neck of the bladder, and at times quite severe.

Examination.—The patient is a healthy looking man. The prostate is not enlarged, is slightly irregular, moderately indurated with a few adhesions. Seminal vesicles negative. Prostatic secretion contains few pus cells, no lecithin bodies, large number of large and small granule cells. Urine cloudy with pus and staphylococci.

Cystoscopy.—Catheter passes with ease and finds 10 c.c. residual urine. Bladder capacity on forced distention 500 c.c. Tonicity good. Study of prostatic orifice shows a fairly well-elevated median enlargement of the prostate with a shallow sulcus on each side. Both lateral lobes are slightly rounded. There is no sulcus between the lobes in front. Bladder is smooth and not trabeculated. Ureters are normal. Series "P" shows that when handle of the cystoscope is depressed, by looking downward the trigone is not seen. On elevating the handle the trigone becomes visible, but is still partly obscured behind the prostate. Series "A" shows no cleft on elevating the handle or looking anteriorly.

Impression.—We have here a small median prostatic bar with very slight rounding of the lateral margins of the prostate. The symptoms present are obstruction and pain. The prostate is not enlarged and prostatectomy does not seem indicated. We believe that this is a suitable case for the new urethroscopic median bar excisor which we have just completed.

April 1, 1909: Operation, Young; 4 per cent. cocain in bladder and deep urethra. Urethroscopic removal of a small median lobe with urethroscopic prostatectome. The new urethroscope which had been transformed into an instrument to excise the median portion of the prostate was inserted, the beak being made to enter the bladder about 1 cm. The obturator was removed

and a good picture of the verumontanum which lay in the fenestra was obtained. The instrument was then gradually pushed inward, the outer edge of the fenestra overriding the verumontanum and finally the median portion of the prostate was seen to bulge into the fenestra of the instrument, completely filling its lumen. A slight attempt made to withdraw it showed the median lobe was caught in the fenestra of the instrument. The excising tube was then inserted until the cutting portion came up against the middle lobe. A good view was obtained through the interior of this tube showing the middle lobe still in the fenestra. The inner cutting tube was then pushed home, excising the median bar. The instrument was then removed, bringing with it the median portion of the prostate which was found to measure 8 mm. in diameter and 1.5 mm. long. One-half the surface was covered with mucous membrane and the other half, cleanly cut, showed evidence of glandular hypertrophy with slight spheroid formation. No muscle was seen. The operation caused the patient very little pain. He immediately got down from the table, and voided urine easily with distinct improvement, he said. There was a moderate amount of hemorrhage. The patient was instructed to continue use of urotropin and to drink water in abundance.

April 29, 1909: Résumé since operation: Following operation there was a moderate amount of hemorrhage, but he did not have to be catheterized and after two days there was no more bleeding. After six days the patient returned home and took no more treatment.

April 10, 1913: It is now four years since operation. Urination is greatly improved. The patient is now able to retain urine at night for seven hours and during the day voids at intervals of four hours. Urination is free, without hesitation, and stream is large and painless.

The result in this first case was so satisfactory that certain improvements were made on the instrument and other cases were soon operated upon, so that we were able to present before the Second Congress of the International Association of Urology in London in 1911 a detailed report of 20 cases:

The ages of the patients were as follows: Between thirty and thirty-nine years of age, 1 case; between forty and forty-nine, 4 cases; fifty and fifty-nine, 9; over sixty, 6. The residual urine was between 30 and 50 c.c. in 11 cases; between 50 and 100 c.c. in 4; between 100 and 200 in 4; and 460 c.c. in 1 case. Report by return in person, or by letter, states that the patient is well and apparently cured in 14 cases; marked improvement, but with slight obstruction to free urination present in 6 cases, all of whom were over fifty years of age. Of the 13 patients who complained of irritability or pain, 9 state that they are entirely cured. One patient, aged fifty-five, had led a catheter life for five years and had 460 c.c. of residual urine. He now has no residual urine, voids freely 400 c.c. at a time, and is completely cured. This is but a fair example of the splendid results which can be obtained by this very simple procedure, which is unquestionably much freer from danger than either prostatectomy or the Bottini operation. As far as the median bar is concerned, it is more radical than a suprapubic bar excision, because there is no instrument which I have seen, which is so well suited to thoroughly excise the urethral portion of the median bar as this urethroscopic bar excisor.

As the result of these studies the operation was made more thorough. Besides the posterior cut two lateral cuts were added to remove the two ends of the bar, which are probably not completely removed by the first cut. As time went on cases were encountered in which the lateral lobes, although not hypertrophied by rectum, presented definite enlargement at the vesical orifice, but not of a hypertrophic type. In these cases the lateral cut was made first while the instrument was still elevated on top of the median bar, as it was found that when the posterior cut was made first, the instrument would at once sink to the bottom of the cut and lateral cuts made thereafter would not be through the lateral margins, but through the two ends of the median bar. We soon began to encounter cases in which the anterior margin of the prostate was enlarged in the form of a transverse oval ridge or bar, practically identical with some median posterior bars. In these cases we made

the anterior cut first, so as to entrap this anterior bar, and then followed with either lateral or posterior cuts, as the case might require. It therefore not rarely happened that six cuts were made, as follows: 1, anterior; 2 and 3, right and left lateral; 4, median posterior; 5, lower right; 6, lower left; the last two to remove the ends of the median bar as shown in Figs. 869–871. In 1913 we presented a detailed study of 100 cases in which we had used the "punch operation."[1] Again, in 1917, we reported an analysis of 156 punch operations, from which the following excerpts are taken[2]:

Etiology.—Number of patients who had had gonorrhea 43, cystitis at time of cystoscopy 44, localized cystitis 4, vesical calculus 18. Twenty-four patients previously had prostatectomy and punch operation was done to remove a persistent obstructive bar. One patient was less than twenty years of age; 5 between twenty and twenty-nine, 11 between thirty and thirty-nine;

Fig. 856.—Autopsy specimen showing fibrous median bar, slightly dilated urethra in front of it, hypertrophied trigone, and trabeculation of bladder.

39 between forty and forty-nine years of age. The remainder were over fifty, 19 being over seventy, and 3 over eighty years of age. In this paper we classified our cases as follows:

Median bars	Congenital	Muscular		
		Connective tissue	Submucous	Acute or chronic
	Acquired	Inflammatory	Muscular	
		Hypertrophy	Periacinous	

The congenital type were most interesting. They appear usually in young men or have been present since early youth in older men. There were 6 in which there was apparently a definite congenital hypertrophy of the muscle posterior to the prostatic orifice which acted as a bar. In the congenital fibrous type, of which there were 4 cases, the muscle is characterized by very delicate fibers situated in a thin but very compact connective tissue, but with an unusually thick submucosa. Among the acquired groups there were 19 which showed evidences of marked inflammatory connective-tissue formation in various stages as will be described elsewhere. Twenty cases showed definite glandular hypertophy, some of these even in young men, and the picture

[1] Young: Journal of the American Medical Medical Association, 1913, lx, 253.
[2] Young: Transactions of the American Urological Association, 1917, ii, 115–135.

was only different from that seen in hypertrophy of the prostate in that the masses were very much smaller.

Symptomatology.—The symptoms present in these cases were very similar to those of prostatic hypertrophy, and except for duration, the congenital and acquired were alike. There was usually a history of progressive increase in difficulty, urgency and frequency of urination, urinary stream becoming smaller, and finally several attempts were necessary to finish the urinary act. There was often marked pain or discomfort before, during, or after urination, localized either in the urethra or referred to the glans, suprapubic region, perineum, rectum, or bladder. The sexual powers were often decreased or absent. Pain on ejaculation was not uncommon. Such patients following a life of complete unrest from impairment of their sexual powers and the frequent and urgent desire to urinate, and from the difficulty and straining on urination, have their general health seriously impaired and wander from physician to physician, being treated symptomatically for many complaints while the true condition is unrecognized, as the prostate is of normal size and no stricture is present.

The duration of the disease has ranged from one year or less to forty-five years.

TABLE 162

Duration	Cases.
Under 1 year	11
1– 5 years	50
6–10 years	32
11–15 years	17
16–20 years	11
21–25 years	2
26–30 years	2
31–40 years	1
45 years	1
Since childhood	13
Not stated	17

The urinary symptoms were as follows:

TABLE 163

Urinary Symptoms	Cases.
Frequency of urination	108
Hesitancy of urination	51
Urgency of urination	23
Small stream	40
Weak force	31
Sudden stoppage	15
Incomplete urination	14
Retention { Complete	3
Retention { Occasional complete	13
Incontinence	1

Pain was usually associated with urination either before, during, after, or throughout the act, and was located in the following regions:

TABLE 164

Pain	Cases.
Neck of bladder	28
Perineum	25
End of penis	24
Throughout urethra	22
Back	10

The sexual symptoms were as follows:

TABLE 165

SEXUAL SYMPTOMS

		Cases.
Desire	Lost	10
	Impaired	22
Erections	Absent	6
	Imperfect	11
	Painful	1
Ejaculations	Precocious	8
	Absent	7
	Painful	5

On examination, the prostate is usually not enlarged, but often indurated and adherent, occasionally irregular, and sometimes atrophic. The seminal vesicles usually show some evidences of chronic inflammatory change.

The findings in our series of cases were as follows:

TABLE 166

RESIDUAL URINE	Cases.
Complete retention	3
Large residual (over 200 c.c.)	18
Moderate residual (50–200 c.c.)	43
Small residual	78
No residual	11
Not stated	3

When the glands of Home are enlarged they are seen as a small elevation in the anterior part of the trigone near the vesical orifice. When Albarran's group are enlarged they are seen as a small projection posteriorly, elevated above and obscuring part of the trigone and with a cleft on each right and left posterior oblique view. The anterior bar, valve, or lobule is easily recognized if care is taken. The normal concave anterior segment is replaced by a rounded figure, which may be well studied by raising and lowering the cystoscope. The appearance of the bladder in contracture and hypertrophy of the Albarran and Home glands is the same as that in the posterior bar type.

A very important procedure is to examine the prostate with the cystoscope in the urethra and the finger in the rectum. In this way the thickness and the extent of the bar laterally may be determined. Not infrequently a firm collar may be felt around the shaft of the cystoscope and sometimes marked subtrigonal thickening is made out.

In 156 cases the following conditions were found on cystoscopy:

TABLE 167

CYSTOSCOPIC FINDINGS	Cases.
Median bar	134
Lateral enlargement	38
Anterior bar	20
Polyp at vesical orifice	6
Diverticulum	23
Trabeculation	43
Stone	15
Hypertrophied trigone (marked)	3

There have been no complications in this consecutive series of cases except hemorrhage. Usually the bleeding is small in amount and quickly stopped, but in a small number of cases the hemorrhage has been rather profuse.

Results.—Careful studies were made by examination and questionnaire to determine the

results. In all those personally examined the obstruction was found to be completely removed, but where letters had to be relied upon, the patient often stated that he was only partly cured, when on detailed analysis it would be found that the pain and irritation and often neurasthenia which had been present before, had not been completely relieved. We accordingly sent out questionnaires, the replies to which have been tabulated as follows:

TABLE 168

Results	Number of patients.
Cured	83
Improved, 90 per cent.	21
Improved, 75 per cent.	17
Improved, 50 per cent.	12
Improved, 25 per cent.	5
Not improved	13
Made worse	2
Not heard from	3

The patients reporting themselves "90 per cent. improved" had no symptoms of obstruction, but still had slight pain usually in the back or deep urethra. The same is true to a large extent of those reporting themselves 75 and 50 per cent. improved.

What explanation can be made for the poor results in the 5 who were 25 per cent. improved or the 13 who were not improved? Two patients who reported "25 per cent. improved" later showed definite prostatic hypertrophy requiring prostatectomy. The other 3 cases had marked cystitis, one of which had several large diverticula. Of the cases not improved, 5 had cystitis, 3 later underwent perineal prostatectomy, 1 had pain in the posterior urethra and was treated by various methods without relief. Of the 2 cases made worse by the operation, both were hypertrophies which were cured by perineal prostatectomy. There were no deaths, although some of the patients were in extremely bad condition before operation and probably would not have stood a major operation. There have been no serious complications. In some of the cases in this list definite hypertrophy of both lateral and median portions of the prostate was present, and prostatectomy should have been performed instead of punch operation, which has shown itself to be inadequate for such cases.

In the extensive discussion which these papers produced the old literature was dug up, and it was discovered that Mercier had designed urethral instruments to remove the median portion of the prostate. We can only state that we knew nothing of these instruments at the time our first publication was made, but study of the Mercier models as presented by Randall and others shows that his instruments were entirely different from the instrument which we have employed. The long beak and cutting blades on the concave surface, somewhat like a modern lithotrite, would appear unsuited for the work of removing the median bar as the beak would seem to elevate the fenestra so greatly as to make it impossible to entrap the median bar posteriorly, as is readily accomplished in so radical a way with our punch (Fig. 857).

A glance at Mercier's instruments will show that they were entirely different from the instrument devised by us, which was merely a modification of our endoscope for the posterior urethra to which we had added a fenestra and cutting inner tube. From time to time various surgeons have advocated open operation, either perineal or suprapubic, by means of which the prostatic bar was either divided or excised.

In 1874 Bottini endeavored to obviate hemorrhage produced by Mercier's instruments by substituting in Mercier's model D a cautery blade with which to make the incisions instead of with a knife.

Subsequently Freudenburg, Chetwood, and ourselves brought out modifications of Bottini's instrument. Goldschmidt devised a cystoscopic cautery incisor which has had extensive usage abroad.

The reader is referred to an excellent article by Alexander Randall[1] on this subject, accompanied by a voluminous literature, from which we will quote as follows:

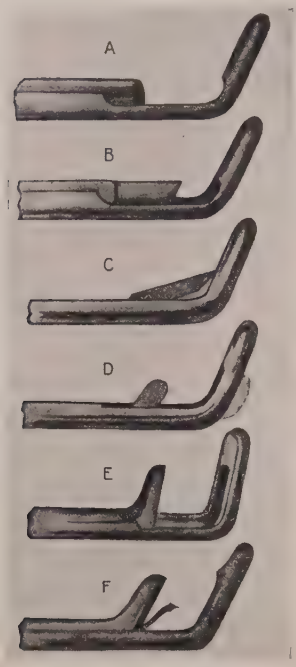


Fig. 857.—Mercier's instruments: *A*, Prostatic excisor, 1839. *B*, Combined incisor and excisor, 1841. *C*, Incisor, 1844. *D*, Incisor, 1847. *E*, Excisor, 1850. *F*, Excisor, 1852.

Guthrie in 1834 described the prostatic catheter which enclosed a blade which could be projected from within the instrument and which cut the bar as the instrument was passed into the bladder.

The most important early work was that of Mercier who brought out a series of instruments for incising or excising obstructive bars. These are shown in the accompanying illustrations. The first was a single conical excisor. He combined this later with an inclosed incising blade and between 1844 and 1847 developed two different models of simple incising instruments. His later models simulated lithotrites (Fig. 857).

In speaking of subsequent hemorrhage and his means of combating it, Mercier says, "It is the only serious accident which I have observed to result, but I have never failed to overcome it in 300 cases, some of which I have operated on several times (1856)." Although he had practiced incision in many cases, he preferred excision.

In 1913 the first comprehensive study of the actual obstructive tissue at the orifice was published by Young, comprising the conclusions drawn from over 100 cases, in which he had excised the obstructions by means of a special instrument, and subjected the tissue removed to microscopic study. This work is of immense value, not only as being the sole investigation of so large a group of cases, but especially because it embraces the study of the actual obstructive tissue as it occurs at the vesical orifice. Since the publication of this work, covering such a large group of cases, the previously obscure field of the pathologic histology of this condition, aside from its cause, has become more clear.

Very early in our operative work with the punch instrument we encountered cases in which the hemorrhage was annoying. In some cases it was necessary to

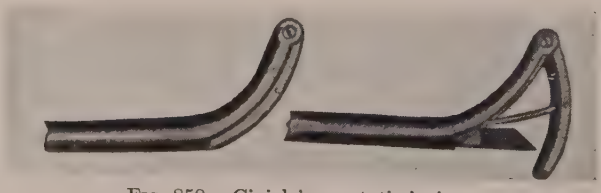


Fig. 858.—Civiale's prostatic incisor.

employ a large catheter and not infrequently clots had to be evacuated by suction. Accordingly, in 1911, while in Berlin we designed and had Löwenstein construct a punch instrument in which the inner cutting tubular knife was replaced

[1] Prostatisme sans prostate, New York Medical Journal, 1915, cii, 1123–1132 and 1177–1186.

by a tubular cautery with which the bar, entrapped in the fenestra of the punch, was to be excised. In order to keep the instrument cool we made the outer portion of two tubes with a narrow space between them for irrigation. This, the first cautery punch, is shown in Fig. 859. The technic of its application is as follows: The instrument with the obturator in place is introduced within the bladder which has been filled through a catheter. The obturator is withdrawn and as the fluid escapes the outer sheath is drawn rapidly outward so as to entrap the desired portion of the prostate. A suction tube is introduced and the fluid evacuated from the tube. The cautery, which has been previously adjusted, so that the current is sufficient to bring it almost to a white heat, is then introduced and when the inner tube strikes the entrapped bar, the current of water through the outer tube is turned on to keep the instrument cool. The electrical current is then started and after waiting about one-half minute for the cautery to become hot, it is slowly pushed home by means of the rack and pinion externally. As soon as the operation is completed, the cautery tube is withdrawn for about 2 cm. and the current is turned off. The cautery is then removed and cleaned by burning off the tissue within its lumen. Turning the instrument first to one side and then to the other,

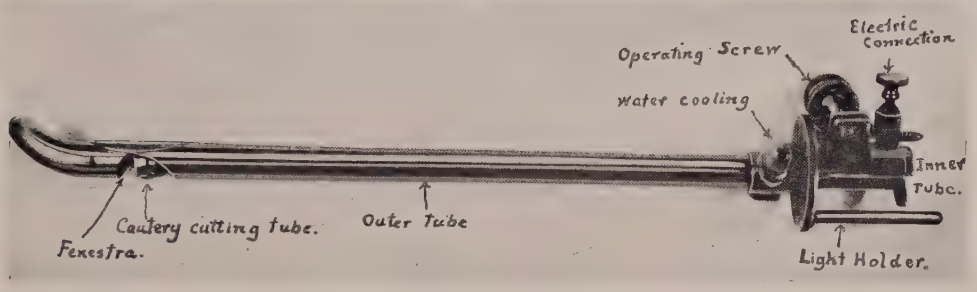


FIG. 859.—Young's cautery punch, 1911 model, with double outer tubes providing for continuous flow of water to keep instrument cool.

the operation is repeated and the two ends of the median bar excised by electrocautery. It may also be turned in other directions should this be desired. No retention catheter is necessary after the cautery punch and only rarely is there even the slightest hemorrhage.

Another modification of the punch operation which we have carried out is as follows: The ordinary punch instrument, with a sharp cutting tubular blade, is introduced and the bar excised and plug of tissue withdrawn. Holding the instrument steady in the position in which the cut was performed, the inner tube is then removed, the cautery tube from the cautery punch introduced, and the current turned on when it reaches the site of the excision so as to coagulate thoroughly the surface of the cut area in the prostate. Additional cuts are made in the same way, each being subsequently cauterized The advantage of the latter method is that the same extensive excisions can be carried out with the cutting blade and large pieces of tissue secured for pathologic examination as with the ordinary punch operation, while the hemorrhage is completely stopped by cauterization of the wounds made. The same effect can be secured by using a simple straight surgical cautery which is long enough to reach the inner end of the punch sheath when introduced within it, or by heating the obturator over a Bunsen flame and

introducing it quickly through the outer sheath of the punch to the region to be cauterized.

The value of the cautery punch has been brought into great prominence by Caulk, who several years later (1920) quite independently constructed and used a cautery punch. In the Caulk instrument he has employed our usual outer tube with the fenestra and has not thought it necessary to make use of double walls so that the irrigation can be carried out to keep the instrument cool. The cautery blade which he uses in the interior apparently causes no untoward effects from its heat, and he has now reported a long series of cases in which he has carried out this operation.[1]

Caulk describes his operative technic as follows:

After cocainization of the urethra, as for any instrumentation, the sheath with its obturator is passed into the bladder. The obturator is withdrawn and the urine is evacuated. The instrument is then pulled forward until the internal orifice engages in the slot. The instrument is pressed firmly downward by the left hand, at the same time drawn forward. To accomplish this, press downward with the little finger and upward with the thumb; at the same time the elbow is firmly supported on the knee so that the instrument, if it once grasps the orifice, bears very firmly downward, and is fixed without the slightest motion from then until completion of the operation. Evacuation of the contents of the tube is then done with the aspirator and cotton pledgets. The light is reflected and the orifice identified, and classified. We are usually able to tell the type of orifice, whether glandular or sclerotic. Infiltration with 1 per cent. novocain is begun, the needle hugging the lower part of the shaft of the instrument so as to infiltrate below the line of burn. This field is then dried and the orifice is touched with the rod of the evacuator, and if there is no sensation elicited, the orifice is then ready for burning. The cautery blade is then passed through the sheath until it engages the obstruction. In the meantime, the left hand, which is firmly holding the orifice within the slot of the instrument, is never budged from its original position. No extensive sloughing has followed any of the operations. The burning is so superficial and so rapid that one should not anticipate extensive sloughing. There has never been the slightest incontinence following this operation. Absorption with reaction following this operation has been rare. In only 12 patients was there a rise in temperature. Epididymitis has occurred in 8 per cent. of the patients.

There was immediate improvement in the stream; that is, within a week, in $66\frac{2}{3}$ per cent. of all these patients. The remainder showed improvement at intervals from two to eight weeks. Several of our best results have had considerable difficulty, frequency, and irritation, lasting as long as seven to eight weeks. In the bar cases, the average night frequency before operation was four times; after operation, once. In the collar obstruction and those with lobules before operation, night frequency was four times, afterward once. Sixty per cent. have been entirely cured of night frequency. In the severe contractures night frequency was six times, afterward once. Before operation all were required to get up at night. After operation 40 per cent. were entirely cured. These contractures have given surprisingly good results. Only 1 patient of this group received no benefit. There have been two recurrences; one within six months, another within a year. In other words, about 70 per cent. have remained entirely free of symptoms from one to four years.

The comparison of the residual urine before and after operation is as follows:

Bars.—Beforehand was 4 ounces, afterward $\frac{1}{2}$ ounce.

Collars.—Average beforehand was 11, after operation $\frac{1}{2}$ ounce; 88 per cent. of these two classes were entirely cured of residual urine.

Contractures.—Average of residual urine before operation, 5 ounces; less than $\frac{1}{2}$ ounce after operation; 28 per cent. of these patients had no residual before operation; 80 per cent. of these who had residual urine were entirely cured of it.

Imperfect Results.—I have classified these into (1) those individuals who received not the slightest benefit from the operation, 4 per cent; (2) those who received partial relief, 5.5 per

[1] Caulk, J. R.: Journal of Urology, 1920, iv, 399–408; 1924, xi, 45–62; Boston Medical and Surgical Journal, 1924, cxc, 700–706.

cent. and (3) those who had a good immediate result, but showed evidence of return of previous trouble, 4 per cent.

The recurrences have all come within one year. There has never been a stricture of the urethra in any of these older cases. We have employed this method very successfully as a post-operative measure in certain cases of delayed closure following prostatectomy in 15 cases. One of the most encouraging fields for the employment of this instrument has been in cancer of the prostate. We have used this instrument on 10 patients—most of them have been inoperable.

In conclusion, I feel it is fair to assert that this operation, with its simplicity in technic, its freedom from serious complications, and its negative mortality, should occupy a more important field in urology, and I believe that if urologists would interest themselves more definitely in the proper study of these particular types of vesical orifices and utilize its technic, they would be naturally gratified with the results, and I feel confident that the general mortality of prostatic surgery would be greatly lessened.

In 1913, A. R. Stevens[1] first described the use of the high frequency current to destroy prostatic bars through a cystoscope. Steven's first case is one of true median bar formation, resulting in a remarkable cure after six applications. When the treatment began, the patient had 700 c.c. of residual urine, which was reduced to 45 c.c. with complete cessation of all subjective symptoms. Georges Luys[2] describes a

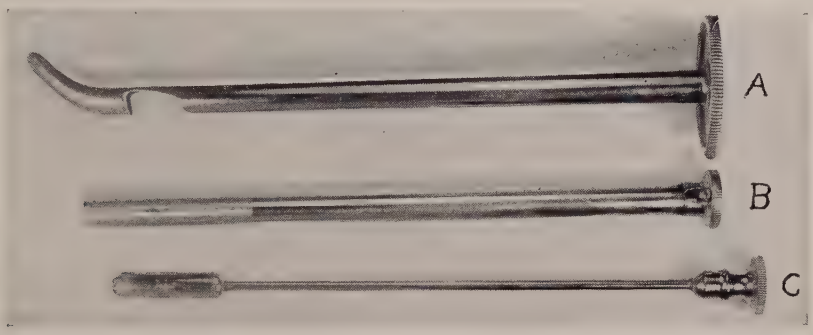


Fig. 860.—Young's punch: A, Outer sheath with fenestra, made of non-rusting steel. B, Inner cutting tube with inner portion of non-rusting steel, outer portion provided with notches to connect with motor if desired. C, Obturator for introduction or removal of instrument.

method which he has employed since 1914, which he terms "forage" of the prostate. This operation is performed through an endoscopic tube and the hypertrophied portion of the prostate is destroyed by a galvanocautery knife, unless the hemorrhage is pronounced, when one must employ electrocoagulation. Heavy blades are required and the cautery knives should have various shapes, the curved blades being necessary to scoop out the lateral lobes and the circular blades to ream out the circumference of the prostatic canal. Luys reported that he had observed 30 cases which had given "uniformly perfect results." We have had no experience with this procedure, but have employed fulguration with results less satisfactory than with the punch. Heitz-Boyer employs electrocoagulation through an endoscope with very strong current and reports excellent results in cases in which he has used it. Caulk, Luys, and Heitz-Boyer are inclined to use this cautery procedure in cases in which definite hypertrophy of the prostate is present. Our experience would indicate that when definite hypertrophy, not confined to a small median posterior lobe, is present, prostatectomy is the operation of choice. In our early

[1] New York Medical Journal, 1913, xcviii, 170–172.
[2] Journal of Urology, 1919, iii, 17–24.

work with the punch instrument in which we aimed to find out its limitations, we operated upon a series of small hypertrophies and the results obtained were far from satisfactory. In only a few cases was there marked improvement, in several the obstruction increased and occasionally complete retention of urine set in, requiring prostatectomy. We, therefore, feel that the punch operation and its modifications should be confined to median bars, very small rounded lobes in the median portion with no lateral enlargement present, fibrous contractures of the prostatic orifice, and congenital fibrous or muscular bars of the median portion.

Technic of Punch Operation (Figs. 861–868).—We have already referred briefly to the methods originally employed and the variations which have come about as the result of experience. When on examination a patient (generally younger than fifty years) shows a prostate that is little or no larger than normal and on cystoscopic examination a median prostatic bar, a general contracture of the orifice, an anterior valve, or a very small rounded median posterior lobe, apparently unassociated with hypertrophy of the lateral lobes as shown with the cystoscope intravesically and the urethroscope, a punch operation is usually carried out. If the residual urine is small, the functional tests show good kidneys, and the general condition of the patient permits, the punch operation is carried out without delay. If, however, the residual urine is large, the kidney function impaired or there be any other reason for preoperative treatment, this is carried out in accordance with the rules laid down for prostatectomy and other operations upon the prostate.

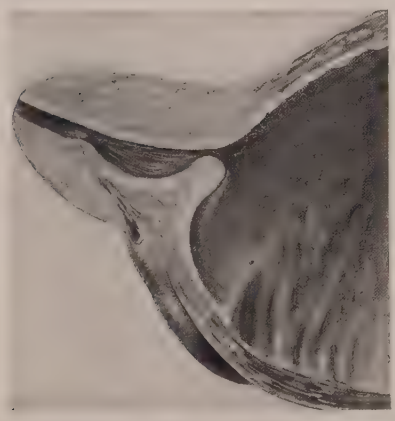


Fig. 861.—Punch operation. Longitudinal section showing typical median bar elevated above the trigone without enlargement of the prostate.

If the prostatic bar is small and the amount of tissue to be removed is not too great, we usually carry out a cautery punch operation, but, instead of making one cut as employed by Caulk, we make one posterior cut to remove the central portion of the median bar and then one on each side to remove the two ends of the median bar. We have found a simple injection of 4 per cent. procain into the bladder and deep urethra sufficient when the patient has also been given morphin, grain $\frac{1}{4}$. We usually employ the instrument at almost white heat and thus we are able to make the cuts much more quickly and with practically no force. The patient rarely complains of more than slight pain. The advantage of the quicker cut is that, although a high degree of heat is employed, the extent of necrosis is probably less after operation. No catheter is employed and the patient remains in the hospital only a few days. We have never had more than very slight bleeding and have never had to use a catheter in any of our cases. When the original cold punch with cutting inner tube is used, where larger cuts are desired and where we are anxious to secure a specimen for microscopic study, the technic is as follows: The patient having received morphin, a catheter is passed into the bladder, which is emptied and 4 per cent. novocain is introduced into the bladder, posterior and anterior urethra. After five minutes the catheter is again introduced, the bladder filled with fluid, the catheter withdrawn, and the punch

instrument with the cutting blade (pushed home) introduced. If there be an anterior bar or valve present, an anterior cut is the first to be made. The instrument is turned so that the fenestra is upward and well in the bladder cavity. The cut-

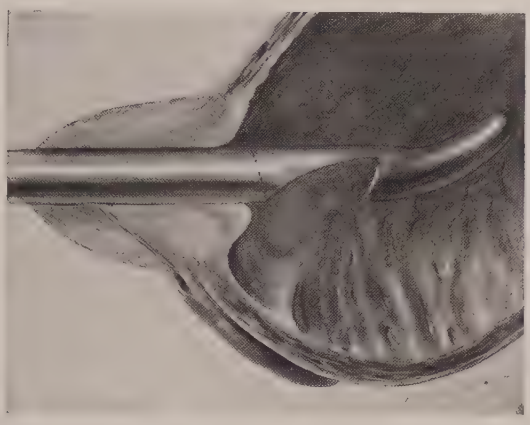


FIG. 862.—Punch operation: "Punch" instrument introduced well into the bladder, the inner tube drawn outward, thus opening the fenestra through which urine begins to escape. The median bar is seen depressed by the shaft of the instrument.

ting inner tube is then withdrawn 2 cm. or more; there is a rush of fluid through the tube (Fig. 862) and the operator quickly draws out the instrument to stop this escape and in so doing entraps the anterior valve or bar at the prostatic ori-

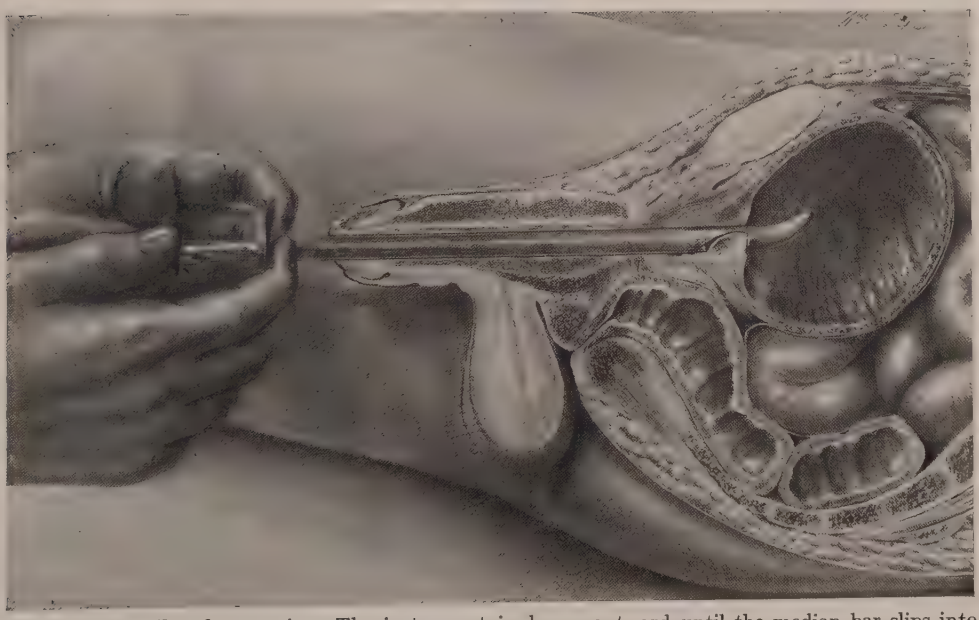


FIG. 863.—Punch operation: The instrument is drawn outward until the median bar slips into the fenestra, stopping the flow of urine and preventing any further withdrawal of the instrument. The hands of the operator are shown ready to push the inner tube home.

fice (Fig. 863). By clearing the instrument out with evacuating tube and swabs, and using the light carrier, a good view of the tissue projecting through the fenestra may be obtained, but in practice we have found this entirely unnecessary, as

with experience one may be certain as to the portion of the prostate which has been caught within the tube. The inner tube is then rapidly pushed home, cutting away the tissue caught within the fenestra (Figs. 864, 865), which is then removed from the interior of the instrument by means of a long alligator urethral

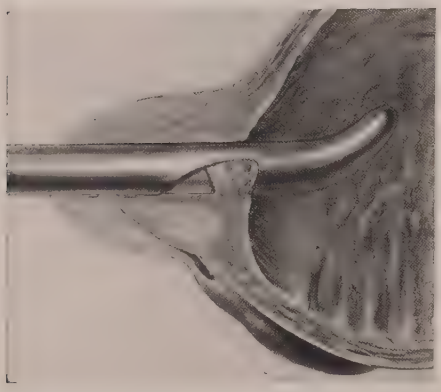


Fig. 864.—Punch operation: The sharp inner tube is pushed home, excising the median bar as shown.

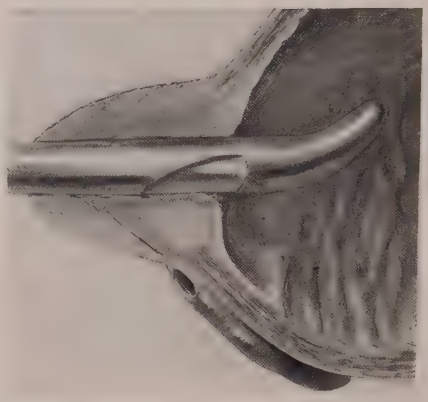


Fig. 865.—Punch operation: The inner cutting tube has been pushed home and the median bar is excised.

forceps (Fig. 866). Holding the outer tube firmly in place, we generally withdraw the cutting inner tube and introduce a cautery blade by which the cut is thoroughly seared and the oozing surface coagulated. This completely avoids deep necrosis and subsequent sloughing. The inner tube is then reintroduced and the instrument carried into the bladder, where it is used to attack the other portions of

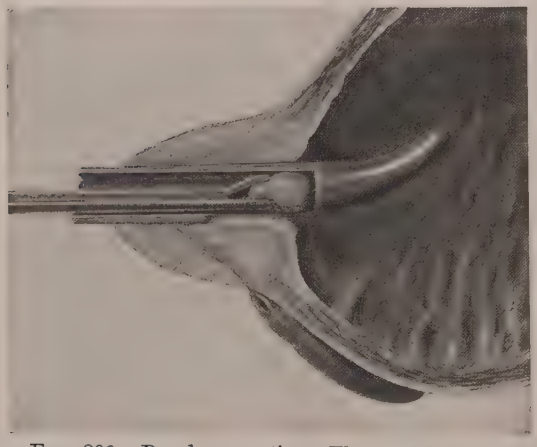


Fig. 866.—Punch operation: The excision of the median bar is complete and the instrument is shown in section with the urethroscopic forceps in place to seize and withdraw the excised piece of tissue.

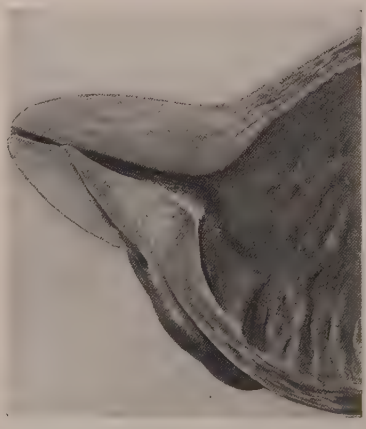


Fig. 867.—Punch operation: A sagittal section of the prostate showing the appearance after completion of the operation and withdrawal of the instrument.

the prostate which are slated for removal. If one or both lateral margins are to be attacked, this is done before the median portion is excised, in order that the instrument may be held up on the surface of the median lobe and properly engage the lateral margins. As stated before, if the posterior cut is made first, the instrument drops to the bottom of the cut and the lateral margins escape when

the lateral cuts are made. The latter then only removes the ends of the median bar. When the midposterior portion is to be removed, the operator, after introducing the instrument into the bladder, turns the fenestra downward, draws the inner cutting tube outward and, as the fluid rushes out, pulls it quickly outward until stopped by the median portion which becomes entrapped in the fenestra.

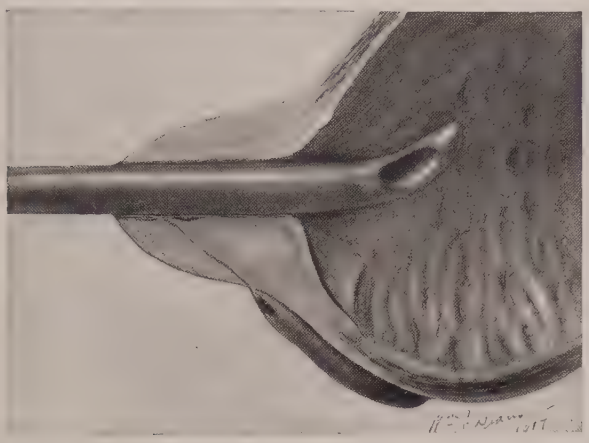


FIG. 868.—Punch operation: After completion of the operation a large catheter, preferably 28 F., is introduced and left in place to drain the urine and produce hemostasis.

In some cases the posterior boundary of the trigone (generally a hypertrophied ligamentum interuretericum) is caught in this procedure, and to be sure that this is not the case, the operator should turn the instrument 90 degrees before making the posterior cut. If the trigone has been caught, it will thus disengage itself and the instrument may be drawn out until the fenestra is really caught by

FIG. 869.—Punch operation: Specimen removed from case with lateral and median bar enlargement; *R* and *L*, right and left lateral cuts; median bar removed in three cuts (P. R. L.). B. U. I. Path. 3550.

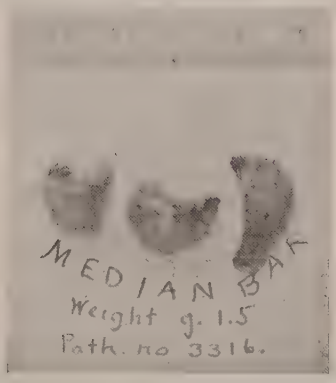


FIG. 870.—Punch operation: Case of median bar obstruction removed by three cuts (P. L. R.). B. U. I. Path. 3316.

the prostatic margin. Turning it backward 90 degrees, the median bar will then be surely entrapped and all fear of having caught the trigone eliminated. The posterior cut is then made as previously described and the surface seared with the cautery blade. We have found it generally desirable in small median bar cases to remove the ends of the bar as well as the middle, and practically always, after the

median cut is made, make additional cuts directly to the right and to the left. In these cuts a much smaller amount of tissue is removed than from the posterior, but they are sufficient to add materially to the total amount excised. The accompanying photographs show graphically the amounts removed from various cases (Figs. 869–871). The evolution of the "punch" from the simple posterior urethroscope is shown in Fig. 872. Another modification of the punch operation which we have previously described is that of the rotary punch operation. The instrument employed is the same, but instead of pushing the inner cutting tube home, it is connected with a small rapidly revolving electric motor (Fig. 873), which is connected with the inner cutting tube as it is pushed home. The object of this technic is to excise a larger piece of tissue and in this it is undoubtedly successful, but the question arises whether a small additional amount removed is essential, and the slight complication added to the technic is to be considered. If the inner cutting tube is made of fine steel and kept sharp and free from rust (all of our instruments are made of non-rusting steel), the amount of tissue removed with a direct punch technic is sufficient. The use of the cautery to control hemorrhage makes it absolutely unnecessary to introduce a catheter. Where cauterization with electrocautery[1] or heated obturator are not used, a catheter may or may not be necessary. In our early operations none was employed and in most cases there was no difficulty encountered, but in a few cases the amount of hemorrhage was sufficient to produce clots which could not be passed by the patient and evacuation was required. For a time we used a coudé gum catheter, but gave this up because hemorrhage was promoted by it. We last employed a large catheter, the end of which, for 4 or 5 cm., was carefully covered with a layer of kephalin. This was very efficient in stopping the hemorrhage, but the difficulty in securing a good grade of kephalin put an end to this technic. An ordinary large catheter will usually suffice to stop all hemorrhage with the "cold punch" (Fig. 860), but in many instances it will be necessary to evacuate the clots by suction through a tube. In over 300 cases, however, there have been but 2 in which the hemorrhage was not controlled and in which suprapubic drainage was employed (by another operator). One of these was a case of tuberculosis of the bladder with a median obstructive bar and in the other case the prostatic orifice had been attacked with the cystoscopic rongeur and then with the punch. With both of these a bleeding artery was found on suprapubic cystotomy. In the other 300 cases the ordinary catheter drainage was sufficient and satisfactory. The punch operation is, in fact, one of the simplest and most quickly performed operations in urology.

Fig. 871.—Punch operation: Specimen removed by four cuts—anterior, posterior, right and left lateral posterior—size normal as seen by centimeter scale. B. U. I. Path. 3311.

[1] The ordinary straight surgical electrocautery blade (which is not too large to pass down the outer tube) may be used after the cut is made to cauterize the bleeding surface.

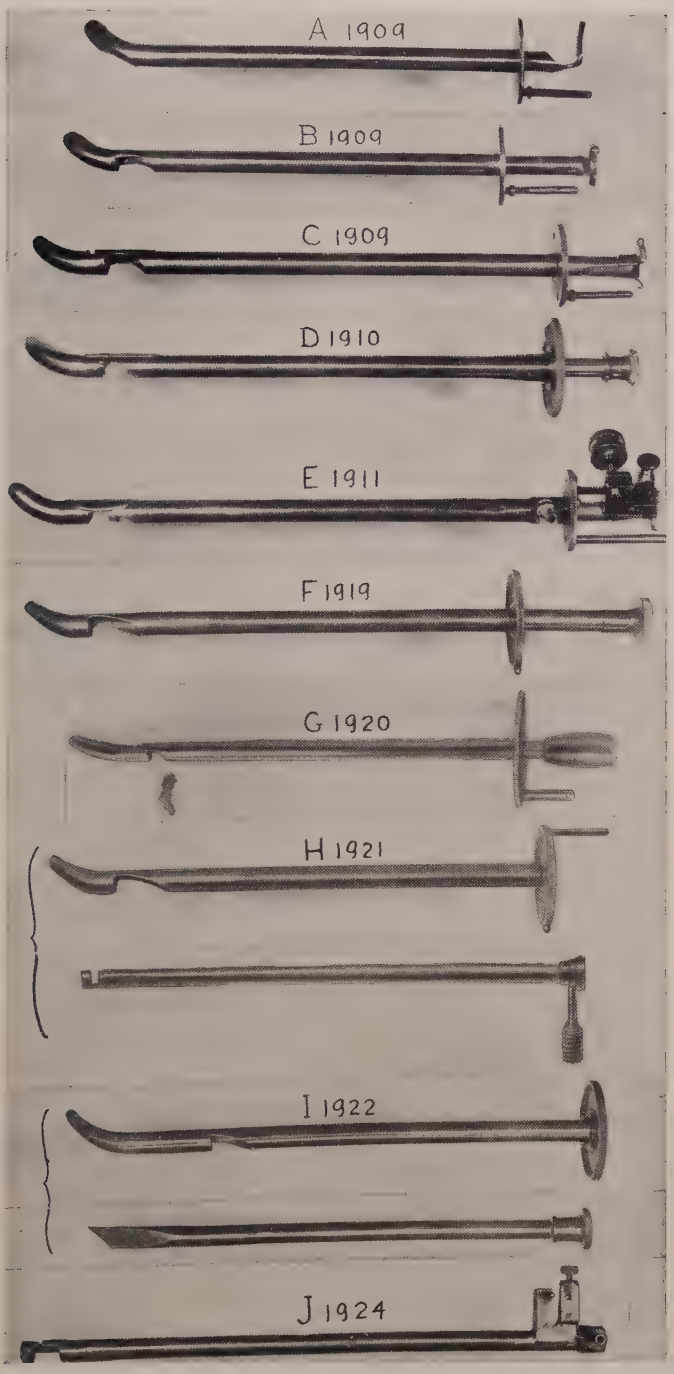


FIG. 872.—The evolution of the punch instrument: A, Young's posterior urethroscope, 1909. B, Young's first punch made by filling end of urethroscope and making fenestra on tube to entrap median bar, 1909. C, Special punch made larger diameter (29 F.), with oblique cutting tube, 1909. D, Punch with teeth on each side to prevent escape of tissues, 1910. E, Young's cautery punch with double walls for cooling by continuous stream of water, 1911. F, Rotary punch operated by small electric motor, 1919. G, Baby punch, 1920; used to excise congenital prostatic valves. H, Caulk's cautery punch without cooling device, 1920. I, Punch instrument with Geraghty's inner cutting blade, sphincterotome, 1922. J, Young's second cautery punch with cooling device within inner cautery tube, 1924.

Local urethral anesthesia is entirely sufficient. In our experience it has not been necessary to make the injection into the substance of the prostate employed by Caulk. The operation is so quickly over, either when done with the cutting tube or cautery punch, that the pain produced is often no more than that of cystoscopy in the same case and nothing like so prolonged, even when three or four cuts are made. In only a few instances, which presented long-continued symptoms of great pain, has general anesthesia been employed in our clinic. Further modification of our punch operation, and through the same outer sheath, is the instrument for sphincterotomy, described by Geraghty[1]: "It consists of a wedge-shaped 'concave knife' which accurately fits in a No. 28 F. endoscopic tube, similar to the outer sheath of Young's punch instrument." This knife, when pushed home, simply incises the tissue entrapped in the fenestra of the instrument, instead of excising it as done by our hollow cutting or cautery tubes. The small amount of hemorrhage following this operation led Geraghty to hope that simple incision would be sufficient to remove the obstruction, especially in those cases in which only a fibrous ring was present. The operation was therefore called "sphincterotomy." The

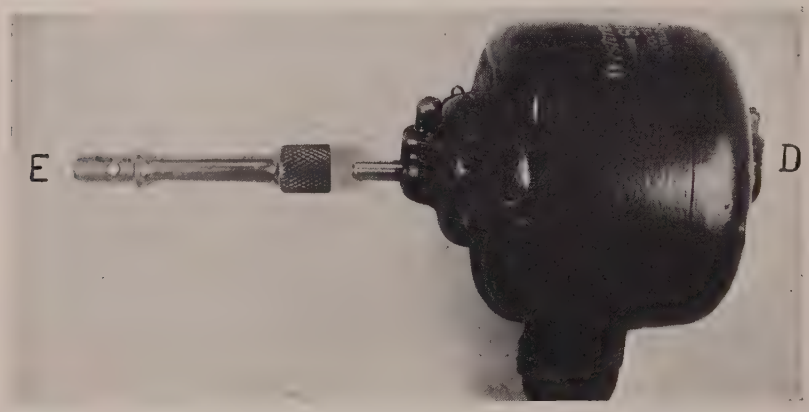


Fig. 873.—Small electric motor and connecting piece (E) used at time of carrying out rotary punch operation. By this means a cleaner cut is made, and more tissue is usually removed.

detailed study of cases included at the end of this section will show what the comparative results are. As a matter of fact, the hemorrhage was not done away with and the results were not good.

Postoperative Treatment of Punch Operation.—If the operation has been done with the cautery, as remarked before, no catheter is necessary, either immediately after the operation or subsequently. The patient usually voids with increasing facility and needs little or no treatment except water by mouth in abundance and possibly internal antiseptics. After a few days in the hospital he is discharged, generally to remain in call or under medical supervision, because in rare instances secondary hemorrhage may occur, requiring attention. No postoperative dilatations are necessary. Rarely one may find it desirable to pass progressively large sounds, particularly if extensive removal of mucous membrane at the vesical orifice has been done. Where the operation has been done with the cutting inner tube, and without cauterization of the wound to stop the hemorrhage, a large retained catheter is generally desirable for at least two days.

[1] Journal of Urology, 1922, vii, 367–369.

Should this become plugged with clots of blood, evacuation by means of a large powerful suction syringe may be necessary and even required during the first twenty-four hours. This is the one inconvenience of the cutting punch operation, and in rare instances a transfusion may be desirable. This usually has the effect of stopping the hemorrhage at once as well as restoring the lost blood. Injections of horse-serum may also be indicated for the same reason and sometimes are very effective. We have never personally found it necessary to carry out suprapubic drainage in some three hundred punch operations which we have done. In two instances other members of our staff have found it desirable to open the bladder suprapubically to stop hemorrhage, and in one of these cases a spurting artery was found at the base of a cyst which had been removed with the cystoscopic rongeur. We believe, however, that the better plan in cases in which pronounced postoperative bleeding occurs is to use the urethroscope or cystoscope, wash out the blood, and apply either fulguration or cauterization at the vesical orifice. This can be carried out without difficulty by means of either the irrigating cystourethroscope or posterior endoscope.

Statistical Study.—At our request, Dr. W. LaRue Sherman has made a very careful analytical study of all cases in which the punch operation has been carried out. This includes symptomatology, preoperative findings, the operation, pathologic examination of tissue removed, the convalescence, immediate results, and ultimate results. In all, 355 cases have been analyzed, charted, and studied. As there is very little definite information in the literature, it seems wise to give in detail the results of this study.

The *symptoms*, of which the patients complained and which have led to the performance of the punch operation, have been as follows:

TABLE 169

Symptoms	Cases.	Percentage.
Frequency	293	82.0
Pain	191	53.0
Difficulty	177	49.5
Small stream	149	41.7
Weak force	140	39.9
Urgency	89	24.9
Occasional complete retention	40	11.2
Incontinence	27	8.4
Sudden stoppage	28	7.8
Complete retention	26	7.2
Urination incomplete	17	4.7
Location of pain:		
Urethral	75	21.0
Bladder neck	65	18.0
End of penis	55	15.4
Perineum	49	13.7
Suprapubic	45	12.4

The accompanying graphic chart (Fig. 874) shows at a glance the symptoms and their relative frequency. As seen in Table 169 and in the chart, frequency of urination is by far the most common complaint. Difficulty and small stream of weak force are also very common. These four symptoms, of course, simply indi-

cate obstruction to urination, residual urine and reduced functional bladder capacity. They do not differ materially from symptoms produced by prostatic hypertrophy. Next to frequency, pain is shown to be the most common and important symptom and was present in 191 or 53 per cent. Pain was distributed as follows: urethral 21 per cent., vesical neck 18 per cent., end of penis 15 per cent., perineum

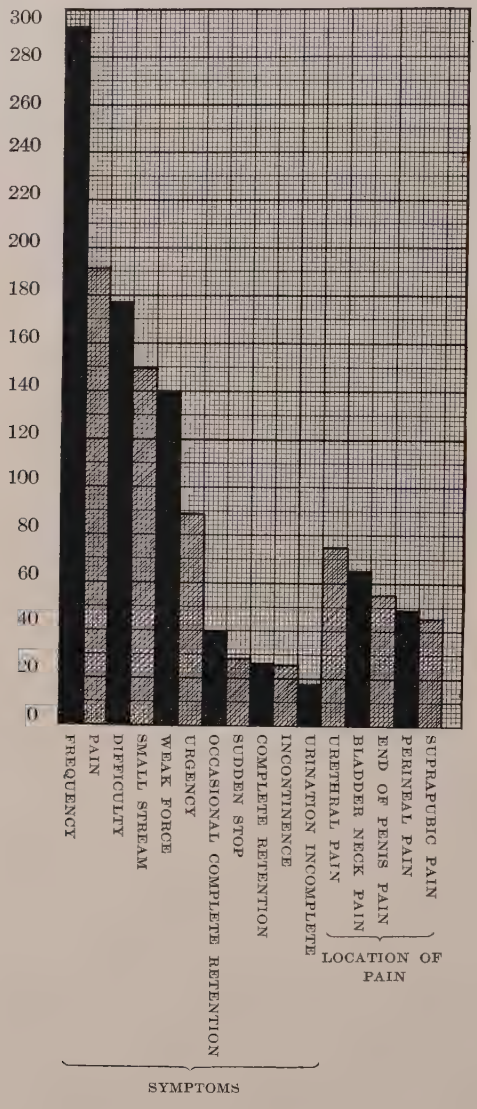


Fig. 874.—Chart showing symptoms in 355 punch cases.

13 per cent., suprapubic 12 per cent. The painful symptoms are distinctly more frequent, more annoying and distressing than in prostatic hypertrophy. Not infrequently the painful symptoms overweigh everything else and the patient demands relief on account of great pain or marked irritation in the lower urinary tract. In contradistinction to prostatic hypertrophy, complete retention of urine

is far less common in these cases. In only 7 per cent. of the cases was there a complete retention of urine at the time of operation, and in 11 per cent. there was a history of occasional retention requiring catheterization.

Sexual symptoms are practically negligible and have occurred for the most part in those patients past middle life. When we consider that 117 patients more than sixty, and 38 more than seventy years old, were operated upon, the impairment in sexual powers is remarkably small and, indeed, practically negligible.

Age of Patients.—The ages of patients were as follows:

TABLE 170

AGE OF PATIENTS

Age.	Number of patients.	Per cent.
Under 15	4	1.1
16 to 20	2	0.56
21 to 25	5	1.4
26 to 30	9	2.5
31 to 35	11	3.0
36 to 40	23	6.4
41 to 45	36	10.0
46 to 50	55	15.4
51 to 60	90	25.2
61 to 70	80	22.4
71 to 80	33	9.2
Over 80	5	1.4

As seen here, the majority of cases are of the prostatic age, there being 90 between fifty-one and sixty, 80 between sixty-one and seventy, and 38 over seventy years of age, totaling 228, or 63 per cent., of the patients in which the punch operation was done.

Among the 145 cases fifty years of age or younger, there were 5 true glandular hypertrophies, leaving 140 cases of the inflammatory or fibrotic type, or 42 per cent. It is seen that this is in marked contrast to the ages of patients with prostatic hypertrophy. Of great interest are those cases in boyhood and early manhood. As seen by the table, there were 18 patients thirty years of age or under, the youngest being seven years of age. On the other hand, our studies show that contracture of the prostatic orifice is found in the very aged, there being 5 cases in patients over eighty years of age.

Etiology.—One hundred and forty-one patients (39.5 per cent.) gave a history of previous gonorrhea, but only 1 patient had urethral stricture, so it is evident that the gonorrhea was not very severe or chronic in many of these cases. In most instances there was an interval of many years between the attack of gonorrhea and its apparent cure, and the onset of urinary frequency, difficulty, etc., but in 4 cases, 1.1 per cent., the gonorrheal infection seemed to be responsible, the patient dating his symptoms back to it.

In 20 cases, 5.6 per cent., the history indicated that the obstruction to urination was congenital. In all of these cases the patient gave a history of imperfect urination since childhood.

As pathologic examination showed that the disease was generally inflammatory in character, it is not improbable that chronic prostatitis starting with gonorrhea plays an important part in the subsequent fibrosis, contracture, and obstruction.

Duration of Symptoms.—In 50 per cent. of the cases symptoms had been present five years or less, but in 87 cases, 24.3 per cent., the patient stated that symptoms had been present for ten years or more, and in some instances for twenty-five years or more. This is in contrast to the history of prostatic hypertrophy in which the symptoms of obstruction have usually been present a much shorter time.

Findings on Examination.—These are shown very graphically in the accompanying chart (Fig. 875) and Table 171. As seen here, the prostate was enlarged, indurated, and adherent in 50 per cent. of the cases. Tenderness was noted in 9 per cent., and irregularity of surface in 13 per cent. The enlargement, except in the 20 cases with prostatic hypertrophy, was usually slight and in no case very marked.

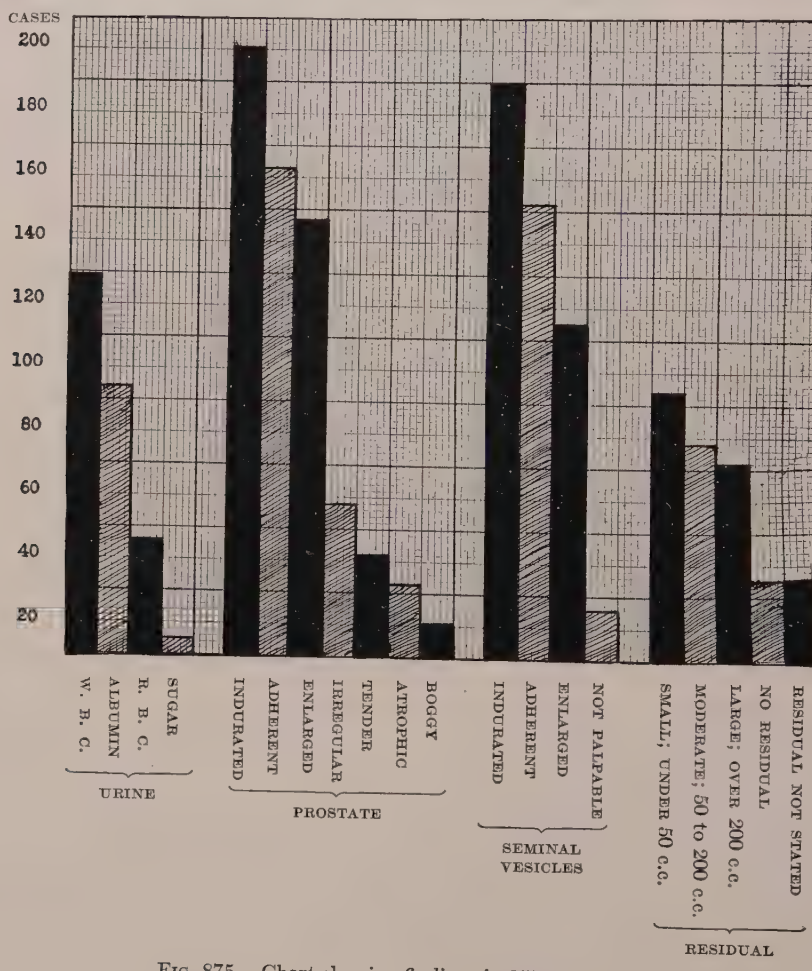


FIG. 875.—Chart showing findings in 355 punch cases.

We have been careful not to use the punch operation in cases of definite prostatic enlargement except in rare instances where a major operation could not be carried out. Chronic inflammation, therefore, played an important part in 50 per cent. of the cases, but in the other 50 was absent. This corresponds fairly closely to the frequency of gonorrhea previously described.

TABLE 171

FINDINGS ON PHYSICAL EXAMINATION

	Cases.	Per cent.
Rectal:		
A. Prostate.		
Indurated	191	53.4
Adherent	153	42.8
Enlarged	137	38.3
Irregular	48	13.4
Tender	32	8.9
Atrophic	23	6.4
Boggy	11	3.0
B. Seminal Vesicles.		
Indurated	180	60.4
Adherent	142	39.7
Enlarged	105	29.4
Not palpable	16	4.4
Urine:		
White blood-cells	139	38.9
Albumin	84	23.5
Red blood-cells	26	7.2
Sugar	5	1.4

Urinary Findings: Residual.—On introducing a catheter or evacuating cystoscope residual urine was found present as follows: Over 200 c.c., 61 cases, 17 per cent. Between 50 and 200 c.c., 68 cases, 19 per cent. Under 50 c.c., 83 cases, 23 per cent. No residual urine, 25 cases, 7.2 per cent. As seen here, the amount of residual urine present is much less than is usually found in prostatic hypertrophy, in about 60 per cent. of cases being less than 50 c.c. Among the large residual urines, however, there are many cases over 500 c.c. and 1 case had 1300 c.c.

Incontinence of urine was present in 27, or 8.4 per cent., of cases.

Urinalysis showed evidence of inflammation in 40 per cent. of the cases, leukocytes being present in the urine.

The findings at cystoscopy are shown in Table 172.

TABLE 172

FINDINGS AT CYSTOSCOPY	Cases.	Per cent.
Median bar	220	61.6
Trabeculation	207	57.9
Cellules	64	17.9
Diverticula	61	17.0
Contracted vesical orifice	56	15.6
Trigone elevated	47	13.0
Cystitis	45	12.4
Calculus	40	11.0
Anterior bar	39	10.9
Right lateral rounded lobe	35	9.8
Left lateral rounded lobe	36	10.1
Trigone hypertrophied	34	9.5
Right lateral enlarged lobe	26	7.2
Left lateral enlarged lobe	28	7.8
Polyp	17	4.7
Right lateral hypertrophied lobe	10	2.8
Left lateral hypertrophied lobe	10	2.8
Large residual—over 200 c.c.	61	17.0
Moderate residual—50 to 200 c.c.	68	19.0
Small residual—under 50 c.c.	83	23.2
No residual	25	7.0
Not stated	25	7.0

Table 172 is of very great interest, as it shows, first of all, definite evidence of obstruction in the form of trabeculation and sometimes diverticula and cellules in almost 60 per cent. of the cases. This obstruction is seen to have been caused by enlargement of the median portion of the prostate, posteriorly, in 77 per cent. of the cases. In the great majority it was in the form of a small median bar. In a few cases it was rounded, in the form of a minute lobe (16 per cent.). Another finding of great interest is the anterior bar or valve which was present in 12 per cent. of the cases. These have not been described by others, but they appear to us to be a very important factor in these obstructions. Contractures of the vesical orifice (15.6 per cent.) also play an important part. In these cases the cystoscope showed a fibrous ring with a rounded margin in the cystoscopic pictures in every direction. The changes in the right and left lateral lobes were in most cases, simply rounding, due to inflammatory thickening (10 per cent.). In a small number of cases definite hypertrophy was present and in some of these a more radical operation should have been carried out. The presence of calculus in 11 per cent. of the cases is interesting, the bar being, we believe, in most cases responsible for the development of the calculus in the bladder. Many of these were in young or middle aged men and the excellent result obtained by the punch operation after removal of the stone shows the importance of combining these two operations.

In practically every case examination was made with finger in rectum and cystoscope in urethra. A fibrous ring around the shaft of the instrument or definite thickening in the median portion of the prostate was found in practically every case in which the punch operation was done. This procedure gives very important confirmatory evidence of the presence of obstruction at the vesical neck and should never be omitted. Often when the cystoscope shows little or no evidence of elevation of the median portion of the prostate, examination with finger in rectum will reveal a distinct thickening, generally with induration, which is sufficient evidence to warrant an operation.

Renal Function.—Before operation renal function was tested in 346 cases and the output in two hours is shown in Table 173. As seen here there are many cases in which the impairment of the kidney is just as severe as is seen in prostatic hypertrophy. In many of these cases preparatory treatment with catheter drainage was required before the punch operation could be safely carried out, the principles guiding this treatment being the same as those detailed elsewhere for prostatic hypertrophy. In many cases the patient had been lulled into a feeling of false security by the fact that his physician had told him he had no prostatic enlargement, and progressive deterioration of the kidney function had gone on from chronic obstruction which could not be made out on rectal examination. These cases show the great importance of cystoscopic examination, with finger in rectum and cystoscope in urethra.

Operation.—The operation carried out in these 355 cases has varied somewhat from time to time. These details have already been considered. The first cases were operated upon at our office with a modified No. 28 endoscope. Only one cut was made and the patient was sent home immediately after. Retention of urine due to clots occurred and since then cases have usually been operated upon at the hospital. Very soon a special punch instrument was made of larger caliber, No. 29 F., with larger fenestra, and we soon began to use multiple cuts, at first 3, then occasionally 5, and sometimes more. We attacked not only the posterior median

TABLE 173

KIDNEY FUNCTION: PHTHALEIN

	Cases.	Per cent.
Under 15 per cent. in two hours	5	1.4
16 to 20 per cent. in two hours	2	0.5
21 to 25 per cent. in two hours	10	2.8
26 to 30 per cent. in two hours	20	5.6
31 to 35 per cent. in two hours	26	7.2
36 to 40 per cent. in two hours	30	8.4
41 to 45 per cent. in two hours	40	11.2
46 to 50 per cent. in two hours	32	8.9
51 to 55 per cent. in two hours	40	11.2
56 to 60 per cent. in two hours	90	25.2
61 to 70 per cent. in two hours	51	14.2
Not stated	9	2.5

bar, but sometimes anterior valves and if present, rounded lateral margins and small lobes. The presence of occasional pronounced hemorrhage led to the development of the kephalin-coated retention catheter which in some cases was distinctly beneficial, in others not.

Hemorrhage also led us to construct in 1911 a cautery punch, and it was occasionally used both as a primary operation and in others after the removal of the cutting tube to cauterize the surface from which the punch had been made. Later, following the idea of Caulk, a non-irrigating cautery punch was employed and later a cautery punch with an interior irrigating system.

The operation of "sphincterotomy" used by Geraghty in the hope of simplifying the punch operation is not included in this list, but will be studied subsequently.

As seen in Table 174, a posterior cut was used in every case, and in 11 cases two posterior cuts were made. In 80 per cent. of the cases, in addition to the posterior median cut, a cut was made on each side. In most cases these were made after the posterior cut and, as a result, the two remaining ends of the median bar were removed and not the lateral portions of the prostate, as might be supposed. This is due to the fact that after the posterior punch is made the instrument naturally sinks to the bottom of this cut.

TABLE 174

LOCATION OF CUTS	Cases.
Posterior	366
Right	284
Left	286
Anterior	94
Right anterior	27
Left anterior	24
Right posterior	64
Left posterior	64

In cases where it was found desirable to remove the lateral margins of the prostatic orifice we almost invariably made these lateral cuts first, while the instrument still remained on top of the median bar, and then attacked the median bar.

Of great interest is the fact that in 94 cases, 23 per cent., it was thought desir-

able to remove the anterior margin of the prostate on account of finding a rounded bar or valve.

Those cuts which were made obliquely on each side were specially designed to attack some small lobule, polyp, or unusual condition seen with the cystoscope. In none except the very early cases was the operation done under the guidance of the eye, the endoscopic feature having been found unnecessary and impracticable, due to hemorrhage. The cystoscopic rongeur was used in a few cases in attempting to remove small pedunculated lobules and in 1 case a cyst. These are described elsewhere. The number of cuts taken follows:

TABLE 175

Number of cuts.	Number of cases.	Per cent.
1	39	10.9
2	21	5.8
3	149	41.7
4	61	17.0
5	27	7.5
6	26	7.2
Over 6	17	

In 355 cases a total of 1209 cuts were made.

In most of the cases with over 6 cuts the additional cuts were made owing to failure to remove adequately the region attacked. In only rare instances were over six cuts employed, and these in cases in which there was enlargement anteriorly on both sides and posteriorly, the anterior cut being directed against the anterior valve, the lateral cut against rounded lateral lobes, and three cuts, posterior and right and left, to remove the median bar. As seen above, however, in 67 per cent. of the cases three cuts or less, directed only against the median and posterior part of the prostate, were required. In some of the cases definite hypertrophy was present and the multiple cuts were made in a vain attempt to remove a lobule which was too large for the fenestra of the punch. These are now treated by prostatectomy.

Anesthesia.—General anesthesia was employed where suprapubic operation was carried out simultaneously with the punch. Among these may be mentioned 11 cases of diverticulectomy and 23 cases of lithotomy. In very rare instances, when the patient was extremely nervous or the bladder small and painful, general anesthesia was given, but in fully 95 per cent. of the cases the operation was done under local anesthesia, consisting in nearly all cases of the use of a hypodermic of morphin, $\frac{1}{6}$ or $\frac{1}{4}$ gr. before the operation, and an instillation of 4 per cent. procain into the bladder, prostatic and external urethra. In some cases this anesthesia was used even where the bladder was extremely small and painful and even where stricture was present. In such cases the patient occasionally complained of considerable pain, but in the great majority of instances the operation was stated by the patient to be no more painful than a prolonged cystoscopy and in many cases less painful, as it is much quicker. The study of these cases convinces us that general anesthesia is rarely necessary and that procain simply injected into the bladder and urethra is sufficient when combined with the hypodermic use of morphin. We have not employed the intraprostatic injection for local anesthesia as used by Caulk.

Postoperative Treatment.—In the early cases no retained catheter was used and

the patient went home from the office. However, an occasional clot and complete retention caused us to send all patients to the hospital and then to use a large retained catheter. For a time a two-way catheter with continuous irrigation was used, but in a few cases the hemorrhage continued, due, we believe, to the constant flow of water through the bladder, which prevented clotting. Consequently, a simple large catheter was employed and for a time this was covered in its inner portion with kephalin, but without much result. When the cautery punch was used, no catheter was employed and no trouble with hemorrhage has been encountered. Clots which block the eye of the catheter have also been of considerable trouble in many uncauterized cases. These almost invariably occur during the first twenty-four hours, not infrequently requiring evacuation by means of a strong suction syringe. In some cases this was very troublesome. In only 20 cases (5.6 per cent.) was hemorrhage very pronounced. In 4 cases it was found desirable to carry out (by others) suprapubic drainage to stop the hemorrhage. In one of these an intravesical cyst had been removed from the prostatic orifice by means of the cystoscopic rongeur and an artery was found spurting at its pedicle. In a second case tuberculosis of the bladder was present, in the third case carcinoma of the prostate, in the fourth case, complicated by nephritis and diabetes mellitus, diabetic coma and anuria supervened and suprapubic drainage was employed to save the patient's life, but without success. The use of the cautery, however, has completely solved the problem of hemorrhage. In no case have we even employed a catheter afterward. In 1 or 2 cases there was slight secondary hemorrhage a week or two later when the eschars came away. As remarked before, in 33 cases a suprapubic cystotomy was done at the time of operation. The punch operation was used simultaneously with prostatectomy, suprapubic 3, perineal 7. In these cases the punch was used to enlarge a fibrous orifice or remove a bar. In the suprapubic case this was done in order to make it possible to introduce the finger into the urethra and to enucleate the lateral lobes. This is a procedure of value and will often facilitate suprapubic enucleation in fibrous cases when otherwise it would be impossible. In 7 cases after removal of the prostatic lobe through the perineum the orifice was found to be contracted and was enlarged by means of the punch. Here again the punch has a very distinct value.

In addition to the care against hemorrhage, infection (epididymitis, cystitis, pyelitis, etc.) very little postoperative attention has been required. In many cases the patient left the hospital within four or five days and generally within a week. The catheter, when used, was generally removed on the second day, but it occasionally remained longer and in rare instances had to be reinserted on account of hemorrhage. Vesical irrigations, to combat infection, were sometimes employed, but, as a rule, nothing was done except to give the patient water in large amounts to drink or by infusion (if required) and some form of internal antisepsis. It has only in rare instances been found desirable to pass sounds after the operation. Strictures have not and apparently do not occur at the site of the operation, and postoperative sounding is, therefore, not required except in the rarest instances. It has been found necessary or desirable to repeat the operation in only 4 cases, as cited before.

Pathology.—It is difficult to present an absolutely accurate picture of pathology from the examination of the specimen removed in all cases. In some cases where the cautery punch was used the tissue was largely destroyed and in other cases

the excised masses are so small as to defy accurate description. In a previous study of our cases they are classified schematically as follows:

- Median bars
  - Congenital
    - Muscular
    - Connective tissue
  - Acquired
    - Inflammatory
      - Submucous
      - Muscular
      - Periacinous
    - Hypertrophy, glandular

The tissue removed with the punch has been found to show microscopically as follows: Round-cell infiltration 125, 35 per cent.; chronic fibrosis 47, 12 per cent.; muscular hypertrophy 6, 1.7 per cent.; carcinoma 23, 6.5 per cent.; sarcoma 1, 0.3 per cent.; tuberculosis 2, 0.6 per cent. The majority of cases showed evidence of chronic inflammation or a fibrosis resulting from it, totaling 68 per cent. If we exclude cases of carcinoma, sarcoma, and hypertrophy on which the operation was done, we find that almost all cases are inflammatory in character with the exception of those in which muscular hypertrophy of congenital nature is present (2 per cent.).

The lesion, as described elsewhere, consists largely of a peri- and intra-acinous infiltration with round-cells and occasional cystic dilatation and intra-acinous epithelial growth similar to that seen in hypertrophy of the prostate. The inflammatory infiltration may invade the musculature distant from the mucosa and eventually may replace the muscle by fibrosis.

Results.—Every effort has been made to determine as accurately as possible the results obtained. Where possible the patient has been induced to return for examination and questionnaires have been sent at frequent intervals to the patient and generally, also, to the physician. In this way we have obtained a report on all but 25 cases since leaving the hospital. In attempting to interpret the tabulated results, considerable difficulty has been experienced on account of the multiplicity of symptoms complained of. Pain figured prominently in many of these cases, due to chronic prostatitis and other conditions. In many of these cases it has been relieved completely, in others not, and the patient has consequently stated that he was not cured, whereas the punch operation has been entirely successful in removing obstruction and in establishing normal urination. In only 45, or 12.6 per cent., of the cases has the obstruction not been removed and in 23 of these the impediment has not been great. But here again we must remember that pain, irritation, and neuroses, present before operation, still interfere with the perfection of result from the patient's standpoint. Two hundred and forty-three patients (67 per cent.) state that they have been entirely and completely cured and 40 cases, 11.1 per cent., almost completely cured in every respect. Among the 20 cases in which glandular enlargement of the prostate was present, 12 were completely cured of obstruction by the punch operation, 3 were considerably improved, 5 had very little if any improvement, and 1 died (diabetic coma). We now almost never use the punch in cases of true hypertrophy unless very small and confined to the median portion.

Eleven patients had cerebrospinal syphilis. Of these, 4 cases were completely cured of obstruction to urination and paradoxical incontinence, 2 were improved 90 per cent., and 4 not benefited. The result obtained in the first 4 cases has been

most surprising, but is in agreement with the good results which we have previously published, when prostatectomy was done on cases of hypertrophy with tabes. It may therefore be stated that when a median prostatic bar coexists with spinal disease, the punch may be definitely indicated and give splendid results.

In 4 cases tuberculosis was present, associated with prostatic obstruction. Two were cured by the punch operation, 1 was not improved, and 1 died in the hospital.

Perineal prostatectomy was carried out at some time subsequent to the punch operation in 17 cases. As stated before, this is due to the fact that the punch operation was used in an experimental way in certain cases of definite glandular hypertrophy with enlargement. In some cases the punch was entirely successful, but in most cases where the hypertrophy was pronounced the operation was a mistake and prostatectomy was subsequently required. In 4 such cases suprapubic operation was carried out.

In this tabulation of results are included also 23 cases of carcinoma of the prostate. Of these, 15 were completely relieved of obstruction to urination by the punch. Four were greatly improved, 1 unimproved. The splendid results obtained here were due to the fact that we were careful not to carry out the punch operation until the size of the prostate had been greatly reduced by radium and the obstruction consisted of a fibrotic bar or ring at the vesical orifice. In many of these cases a catheter life was necessary before operation and in only 1 case has it been necessary since.

Among the symptoms at present complained of there are: frequency of urination 36 cases, 10 per cent.; occasional slight hematuria 3, 0.8 per cent.; hesitation in urination 5, 1.4 per cent.; urgency 3, 0.8 per cent. Two complained of stricture of the urethra. Nine patients state that the bladder is not completely emptied at urination, 2.5 per cent. Seven complain of incontinence. In 3 of these cases it was present before operation, in 2 due to cerebrospinal syphilis. In the other 4 cases prostatic hypertrophy with a large amount of residual urine was present before operation, and has not been relieved by the punch. Prostatectomy should have been carried out in these 4 cases. There is no case of incontinence due to the punch operation recorded in any of our cases. Seven patients on whom the punch operation was done have died in this hospital. These cases are as follows:

1. B. U. I. 2184, aged fifty-four. Slight hypertrophy of the prostate, rounded median and lateral lobes intravesically (such a case would not now be considered suitable for the punch operation). Operation, Dr. B., 3 cuts made posteriorly and on each side, but without success in removing a median lobe. Three additional cuts made. More hemorrhage than usual. Death on third day. Autopsy showed pulmonary embolism. Study of bladder showed that trigone had been caught and deeply cut by one of the posterior cuts. There was extravasation in the bladder wall, the retrovesical veins were thrombosed, probably the origin of the embolus.

Comment.—Case unsuitable for punch. Division of trigone inexcusable.

2. B. U. I. 4940, aged seventy-one. Previous perineal prostatectomy. Multiple diverticula with calculi. Operation, Dr. F., suprapubic diverticulectomy, removal of calculi, enlargement of prostatic orifice with punch. Patient died on the sixth day. Apparently punch operation was in no way the causative factor of the fatal ending.

3. B. U. I. 9004, aged forty-nine. Interstitial cystitis, contracted bladder, contracture vesical orifice, diabetes mellitus, great frequency of urination, pain, strangury. Operation, Dr. F., suprapubic cystostomy for drainage. Six months later patient returns with suprapubic abscess, and great frequency of urination. Operation, abscess opened. September 17th, patient voiding every fifteen minutes with great pain. To carry out cystoscopy it was necessary to give an epidural injection of procain. Cystoscopy showed an irregular prostatic edge, apparently

the cause of obstruction. Although patient had diabetes it was thought advisable to take advantage of the caudal anesthesia to carry out a punch. Operation, Dr. Young. Following operation there was difficulty in obtaining drainage through urethral catheter on account of clots. After thirty-six hours hemorrhage ceased. On the second day patient became nauseated and blood-sugar was found to be greatly increased. Active treatment was instituted. Uremia came on; blood urea 1.4. Death seven days after punch operation. Autopsy showed pyelonephritis.

Comment.—Treatment adopted was inadvisable.

4. B. U. I. 9101, aged seventy-two. Patient admitted with a diagnosis of benign prostatic hypertrophy. Had large residual and very poor renal function. Could not tolerate a retention catheter. Epididymitis came on. Suprapubic cystotomy done for drainage. Blood urea continued high. Two months later, although blood urea was 0.6 gm. per liter, it was thought necessary to carry out a punch operation to cure suprapubic fistula. Operation, Dr. F., punch, followed by rapid increase in blood urea. Patient very toxic and comatose. Death on eighth day. Autopsy showed numerous abscesses throughout kidneys.

Remark.—Punch operation simply hastened patient's death.

5. B. U. I. 9749, aged forty-seven. Contracture vesical orifice, vesical diverticula. Operation, Dr. F., diverticulectomy at which the prostatic orifice was enlarged with the punch. Death two and a half months later. Autopsy showed acute pyelonephritis, hydronephrosis, hydroureter. Death from uremia and infection. Punch operation apparently not a causative factor.

6. B. U. I. 9819, aged sixty-two. History of diabetes four years. Retention complete. Condition bad. Phthalein: Appearance seventeen minutes; first hour, 10 per cent.; second hour, 20 per cent. Examination showed contracted vesical orifice. After six weeks of treatment was sugar free. Punch operation, Dr. G. Recovery from "punch," but urination continued difficult. Retention catheter necessary. Cystoscope showed intra-urethral hypertrophied lobe. Suprapubic prostatectomy. Considerable postoperative hemorrhage. Developed diabetic coma and died on the sixth day. Autopsy refused.

Comment.—Case unsuited for punch operation and too complicated for prostatectomy, from which he died.

7. B. U. I. 10,434, aged sixty-two. Entered hospital April 11, 1922. Examination: Inactive pulmonary tuberculosis, tuberculosis of seminal vesicles and prostate. Tubercle bacilli in urine. Residual urine, 125 c.c. Seminal vesiculectomy and partial prostatectomy under spinal anesthesia. Accidental opening of posterior wall of bladder. Perineal urinary fistula persisting. June 30th, punch operation (Dr. Young) to remove obstruction and hasten closure of fistula. Urinary condition improved rapidly after this, but patient died one month later of pulmonary tuberculosis and tuberculous peritonitis.

An impartial review of these 7 cases who died in the hospital some time after punch operation, we think, will show that in not more than 1 case can the fatal ending be attributed to the punch operation. This case was really one in which prostatectomy should have been carried out on account of definite hypertrophy. The other cases were complicated with vesical diverticula, pyelonephritis, pulmonary tuberculosis, uremia, and diabetes mellitus, and in which suprapubic operations were done. If we exclude these 7 cases, there are 348 cases in which the punch operation was done without a death. If these 7 cases are included, the mortality even then is only 2 per cent. One may, therefore, say that when we consider the age of many of these patients, and the serious complications which were often present, the punch operation is indeed a very benign procedure.

During the fourteen years since the punch operation was first carried out by us, 102 patients have died after leaving hospital. Cause of death: 58 are from cause unknown because persons answering questionnaires failed to state the cause of death. Of the known causes, 10 have died of carcinoma, 3 of tuberculosis, 3 of pneumonia, 3 of cerebral hemorrhage, 5 of heart disease, and 3 of septicemia. Two have died of pyonephrosis, 2 of "old age," 1 of cholecystitis, 1 of cirrhosis of the liver, 1 of sarcoma, 1 of paralysis, and 1 of diabetes.

TABLE 176

RESULTS OF 146 UNCOMPLICATED CASES

	Number cases.	Per cent.
Obstruction cured	99	60.
Ninety per cent. improved	10	6.1
Seventy-five per cent. improved	9	5.4
Fifty per cent. improved	9	5.4
Twenty-five per cent. improved	4	2.4
Obstruction not cured	24	14.6
Urination not complete	4	2.4
Frequency	15	9.1
Hematuria	0	0.0
Cloudy urine	20	12.2
Use of catheter	0	0.0
Pain	5	3.0
Further treatment	31	18.9
Hesitancy	5	3.0
Incontinence (present before in all)	3	1.8
Urgency	3	1.8
Stricture	1	0.61

209 CASES WITH THE FOLLOWING COMPLICATIONS HAVE BEEN DEDUCTED

	Cases.
Carcinoma	23
Glandular hypertrophy	20
Sarcoma	1
Tuberculosis	4
Cerebrospinal syphilis	11
Pyelonephritis	4
Diverticulum of the bladder	61
Calculus of the bladder	40
Cystitis, severe and painful	45

Sphincterotomy.—The following résumé is the result of a careful study by Dr. Sherman of 18 cases which had *sphincterotomy* performed in this clinic. The technic and sphincterotome of Dr. Geraghty were used and the cases are almost all his.

Sixty per cent. of the cases operated upon were above fifty years of age, the eldest being seventy-seven years, the youngest thirty-two years.

The *duration of symptoms* in 44 per cent. was under five years. One case had complained for twenty-four years. Sixteen and one-half per cent. had had symptoms since birth. Forty-four per cent. gave a history of gonorrheal infection. The majority of symptoms complained of, as will be seen from the table, were those of obstruction, 82.5 per cent. having had frequency, 44 per cent. urgency, small stream and weak force, 66 per cent. had difficulty. Sixty per cent. of cases had pain, the pain being located as follows: 11 per cent. in bladder neck, 11 per cent. in the perineum, 5.5 per cent. at end of penis, 49.5 per cent. urethral, and 16.5 per cent. suprapubic. Five and one-half per cent. of the cases complained of sudden stoppage of the urinary stream, 5.5 per cent. led a catheter life; 5.5 per cent. had complete retention; 11 per cent. had hematuria; and 11 per cent. had urination incomplete in one act.

The following physical findings were present on rectal examination:

TABLE 177

Rectal Findings			Per cent.
Prostate:	Enlarged	7	38.5
	Indurated	8	44.0
	Boggy	0	
	Adherent	4	22.0
	Irregular	7	38.5
	Atrophic	1	5.5
	Tender	2	11.0
Seminal vesicles:	Enlarged	1	5.5
	Indurated	9	49.5
	Adherent	3	16.5
	Not palpable	1	5.5

Urinalysis in these cases showed: White blood-cells 88 per cent., red blood-cells, 27.5 per cent., albumin 71.5 per cent. In no case did the urine contain sugar.

Forty-nine and one-half per cent. of cases had large residual urine (over 200 c.c.), the largest being 1250 c.c. Five and one-half per cent. had a moderate residual (50 to 200 c.c.). Twenty-two per cent. had a small residual (under 50 c.c.).

The findings on cystoscopy were as follows: 66 per cent. had contracted vesical orifice; 44 per cent. of bladders were trabeculated; 38.5 per cent. had cystitis; 22 per cent. had median bar; 22 per cent. trigone hypertrophied; 16.5 per cent. trigone elevated; 16.5 per cent. had cellules; and 5.5 per cent. of cases presented diverticula, anterior bar, anterior valve, right and left prostatic lobe enlargement and left lateral rounded lobe.

The operation was performed in the usual way, one cut being made in the posterior portion of vesical orifice, the wedge-shaped knife being thrust through the tissues within the fenestra in the sheath of the instrument. Five and one-half per cent. of cases had severe hemorrhage following operation; 33 per cent. required continuous catheter drainage to control the hemorrhage and to remove clots.

The details used in tabulating results in these cases have been taken from questionnaires identical with those used in the punch cases.

The obstruction to urination was cured in 44 per cent. of cases, 75 per cent. improved in 16.5 per cent. of cases, 50 per cent. improved in 5.5 per cent. of cases. In 11 per cent. of the cases the obstruction was not cured, and in 11 per cent. the symptoms returned later. Sixteen and a half per cent. of cases required prostatectomy one to three months following sphincterotomy to relieve the obstruction. In 16.5 per cent. of the cases frequency still persisted, 5.5 per cent. still complained of cloudy urine and hesitancy. Five and a half per cent. of cases were incontinent following operation. Thirty-three per cent. of cases required further treatment to relieve their complaints.

Comparison of the results obtained in these patients with those of patients who had the punch operation shows clearly which of the two procedures is the most efficacious, from the standpoint of both immediate and ultimate results.

CHAPTER XVIII

OPERATIONS ON THE SEMINAL VESICLES

RADICAL OPERATION FOR TUBERCULOSIS OF THE SEMINAL TRACT

Definition.—We have for several years employed this term in speaking of tuberculosis in any portion of the seminiferous tract (testicle, epididymis, vas, ampulla, seminal vesicles, prostate, or urethra). We prefer this title to genital tract because tuberculosis of the penis and of the scrotum are entirely separate and distinct entities and in no way connected with the subject under discussion. In a preceding chapter we have discussed at length the etiology and pathology of this condition. We have shown that the disease begins, as a rule, in the region of the seminal vesicles and prostate, whence it frequently spreads down the cord to the epididymis, locating most often in the region of the globus minor and probably reaching that point through the lymphatics rather than through the lumen of the vas. Having located in the globus minor it invades the remainder of the epididymis, but may remain there for many months or years without involving the testis, which is resistant to invasion in tuberculosis of the seminal tract.

At the other end the disease may extend into the tissues around the prostate and seminal vesicles, producing an extensive process which may invade the perirectal spaces, then the perineum, with rupture, producing a fistula, either rectal or perineal. From the prostate and vesicles the tuberculous process may either invade the bladder directly, or the urethra. From the region of the vesicles the infection reaches the kidney, ultimately, in most cases. The exact route of invasion has not been positively proven, but it is probably by the lymphatics, either around or within the ureter, and possibly also by invasion of the ureteral lumen as an ascending infection.

Failure of Partial Operation.—We have also cited statistics from our own clinic and elsewhere to show the failure of partial operations in tuberculosis of the seminal tract, both epididymectomy and castration. The continuance of the disease within the prostate and seminal vesicles and invasion of remote organs was demonstrated and the death rate from tuberculosis was shown to be between 27 and 50 per cent.

History of Operations Upon the Seminal Tract.—The first recorded operative attack upon the seminal vesicles is that of Ullman, who in 1889, through a curved perineal incision, carried out seminal vesiculectomy.

Our interest in this subject began in 1900.[1] We carried out a total bilateral excision of the seminal tract through a "suprapubic retrocystic extraperitoneal operation." At this time only two seminal vesiculectomies had been carried out in America, one by Weir, in 1895, through the groin, and another by Bolton, in 1899, through the sacrum. During the next year we operated upon 2 cases by the same technic and it was demonstrated that by this means, the testicles, epididymes, vasa deferentia, ampullæ, both seminal vesicles, and a portion of the prostate could

[1] Young: Annals of Surgery, 1900, xxxii, 557–566.

be removed completely,[1] but the results were not satisfactory. The deep retrovesical wound afforded poor drainage and became the seat of tuberculosis, which in 1 case ended fatally, and in the others led to chronic suppurative sinuses. At that time there had been only 5 cases in which a radical removal of both seminal vesicles had been carried out. The 2 cases which we published were the only ones in which the entire seminal tract on both sides with a portion of the prostate had been removed.

In this paper in 1901 we presented a thorough survey of the literature. In this we found 32 cases of tuberculosis of the seminal vesicles which had been removed by various operative technics. In this series the results were found to be so bad and the mortality so high that we were forced to the conclusion that radical operation for tuberculosis of the seminal vesicles was not justified. In the same review, we showed that the results obtained by epididymectomy in most cases were just as satisfactory as by castration, as the testis was rarely involved, and castration therefore usually unnecessary. It was also shown that it was not safe

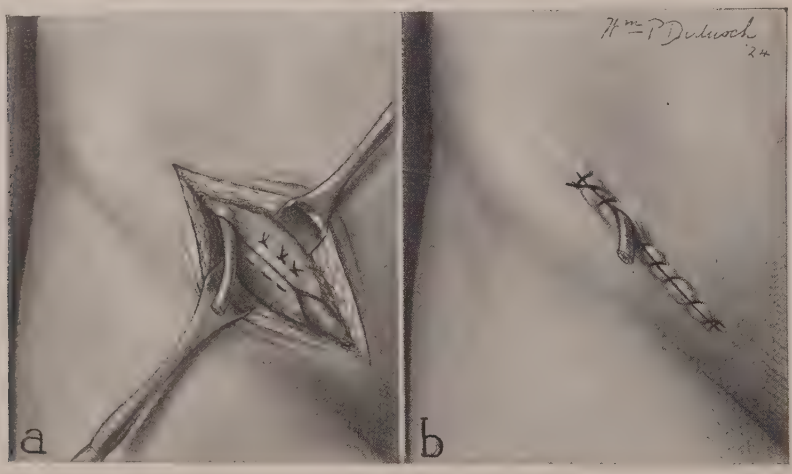


Fig. 876.—Tuberculosis of seminal tract: Vas deferens brought out through incision in groin for drainage and injection treatment.

to divulse the vas. This procedure, which had been carried out by different operators, had resulted in severe extraperitoneal hemorrhage and in tuberculous infection, local and generalized.

Von Büngner's plan of injecting the vas deferens with glycerin containing iodoform was approved, but in addition to this we proposed (Fig. 876) that the vas be brought out through the upper angle of the wound in the groin, where additional injection treatments should be carried out as frequently as possible. By this means we have since injected numerous cases with iodoformized oil and carbolic acid. This paper aroused the interest of Belfield, who soon extended the method to the treatment of seminal vesiculitis and ampullitis (pus tubes in the male, as he called them) and advocated the now popular operation of vasostomy.

In 1909 Cunningham brought up again the treatment of tuberculosis of the seminal vesicles by means of injecting phenol through the vas deferens and reported 34 cases in which good results were obtained.

[1] Young: Annals of Surgery, 1901, xxxiv, 601–636.

During the fifteen years following our first two papers on the subject, our results with epididymectomy or castration, combined with injection of the vasa deferentia, were very variable; some cures were apparently obtained, but in many cases we saw the disease in prostate and vesicles become more extensive and spread to adjacent organs, urethra, bladder, kidneys, etc. In some of these cases the suffering of the patient was so great that we decided finally to restudy the question of operations upon the seminal tract.

In the meantime (1903) we had promulgated the operation of conservative perineal prostatectomy and introduced a two-bladed prostatic tractor, which facilitated the exposure and enucleation of the prostate. Cases of prostatic hypertrophy had been encountered, in which the seminal vesicles were diseased, and in which it was found possible to draw down, thoroughly expose, and to operate upon the seminal vesicles in addition to removing the prostatic hypertrophy. It therefore occurred to us[1] in 1913 to use similar methods for simple cases of seminal vesiculitis.

One of the principal objections to previous operations through the perineum was the frequent injury of the urinary tract and the resultant chronic fistula. In order to avoid these a tractor of more delicate character and longer shaft (Figs. 877, 882) was constructed to pass through the penile urethra into the bladder and thus be used for traction without opening the urethra through the perineum. With this instrument in hand a new and more radical method of attack upon the tuberculous seminal vesicles and prostate was devised in 1913, and at the same time epididymectomy and complete vasectomy were carried out at the one séance. That portion of the vas deferens which had not been removed through the perineum was drawn out and removed through a wound in the groin or scrotum. This operation was presented in greater detail and well illustrated by Mr. Max Broedel in 1918.[2] In 1921 a careful study of 15 cases in which this radical procedure had been carried out along with exhaustive study of the literature and pathology was presented.[3]

We have now (in 1924) a fairly long series of cases in which this technic has been used sufficiently to standardize the procedure, which may be briefly described as follows:

Technic of Radical Operation for Tuberculosis of Seminal Tract.—The plan is: (1) Complete excision of lateral lobes of prostate, seminal vesicles, ampullæ, and lower portions of vasa deferentia through perineum without opening the urinary tract. (2) Excision of remainder of vas deferens, epididymis (and testicle, if involved) through groin or scrotum.

Anesthesia.—Owing to the fact that tuberculosis of the seminal tract is usually secondary to some primary focus in the lungs, peribronchial, or retroperitoneal lymph-glands, and the danger of lighting up such infection by general anesthesia, the operation should unquestionably be done under epidural anesthesia. For this purpose we use procain in 3 per cent. solution and from 15 to 20 c.c. in amount. Satisfactory anesthesia is obtained except for the divulsion of the vas deferens, which may be painful. This is due to the fact that the spermatic vessels and nerves go high up in the retroperitoneal space above the line of sacral anesthesia.

[1] Young: Journal of the American Medical Association, 1913, lxi, 822–825.
[2] Young: Surgery, Gynecology, and Obstetrics, 1918, xxvi, 376–384.
[3] Young: Archives of Surgery, 1922, iv, 334–419.

By the use of infiltration anesthesia in the spermatic cord in the groin the final steps of the operation can be carried out almost painlessly with the exception of the final extraction of the deep vas deferens.

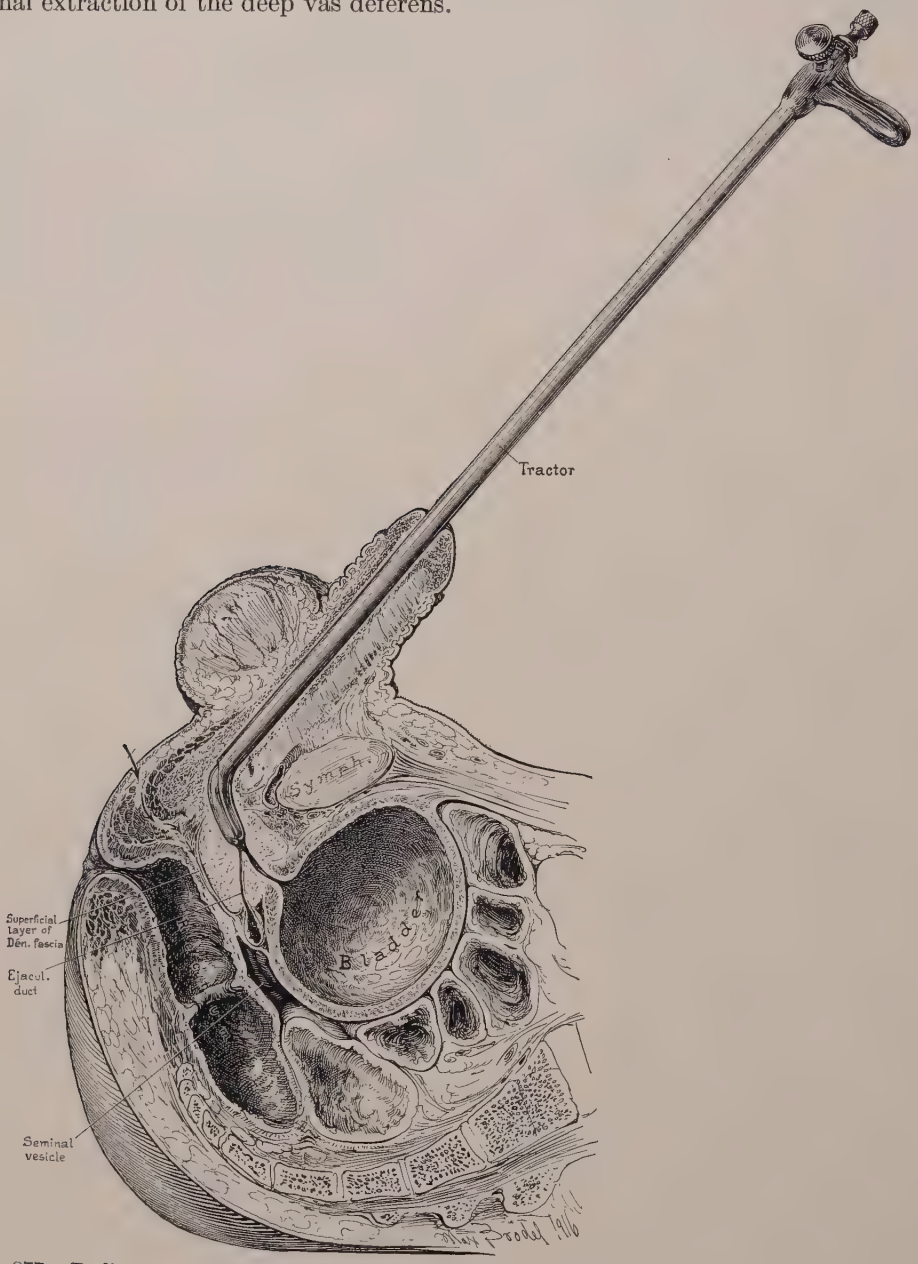


FIG. 877.—Radical operation for tuberculosis of seminal tract: Showing the route followed in operation and anatomic relation of parts.

Position of Patient.—The exaggerated perineal prostatectomy position is used. As soon as the legs have been elevated and the region cleaned up for operation, the long urethral tractor is inserted until the beak reaches the apex of the prostate (Fig. 877).

Incision.—The skin incision is the inverted U perineal incision used in prostatectomy with its center about 3 cm. in front of the anus just behind the bulb in the perineum and extending obliquely backward and outward and around anus on each side for a distance of 8 cm. ($3\frac{1}{2}$ inches) to get a wider exposure (Fig. 878).

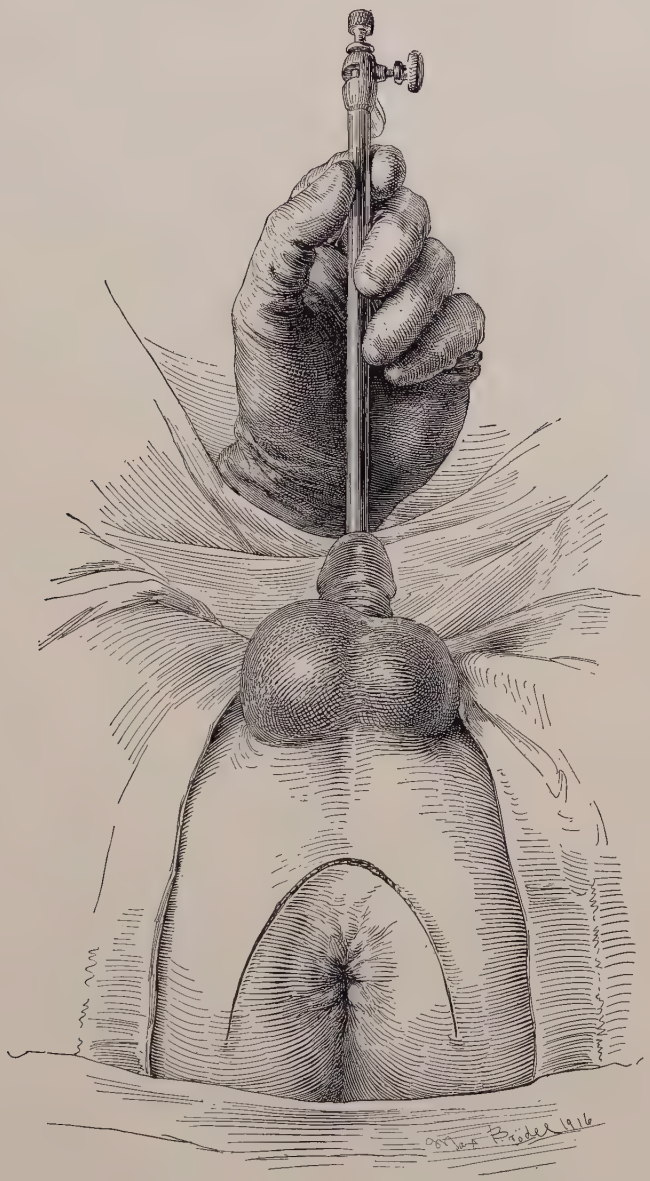


FIG. 878.—Young's radical operation for tuberculosis of seminal tract: A long prostatic tractor introduced into membranous urethra. Skin incision.

The preliminary steps are the same as in prostatectomy, blunt dissection on each side of the central tendon (Fig. 879), division of tendon and recto-urethralis muscle (Fig. 880), and exposure of the membranous urethra at the apex of the prostate (Fig. 881).

At this point the convexity of the tractor (closed) can be felt in the membranous urethra. This instrument is then gently pushed into the bladder (Fig. 882) and opened out and fixed in this position by means of the screw near the outer end. The recent models of this instrument are so constructed that the blades are not opened out completely opposite each other, but only to an angle of about 135 degrees. The object of this is to avoid pressure by the points of the blades upon

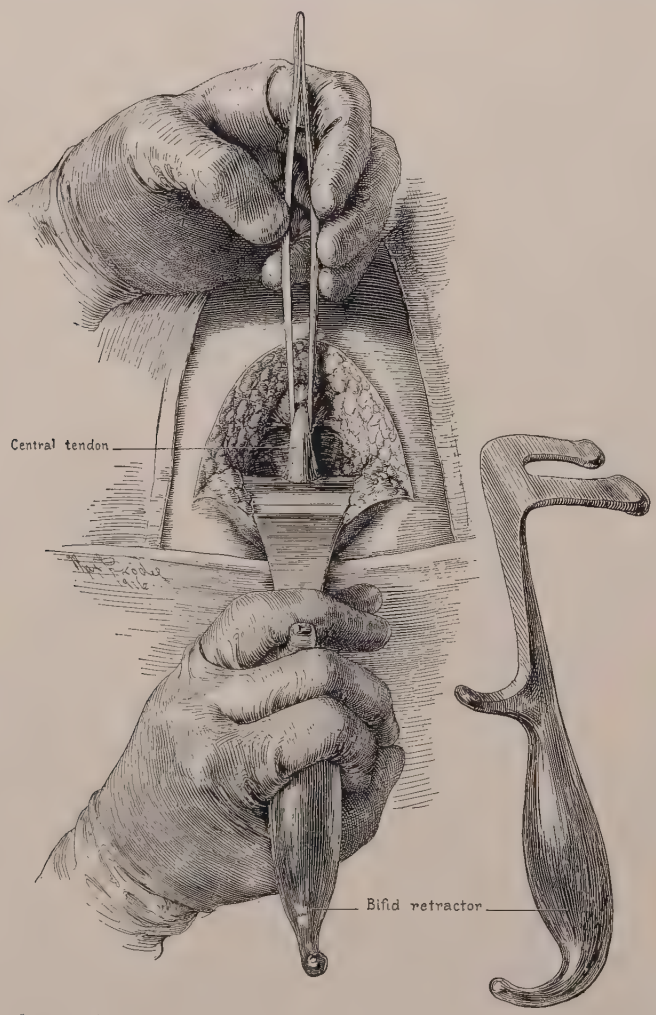


Fig. 879.—Radical operation for tuberculosis of seminal tract: Central tendon put on tension by bifid retractor and picked up by forceps previous to division.

the posterior wall of the bladder (which occurred in some of our earlier cases with the older instruments). With this new instrument, which is constructed on the lines of our cystoscopic rongeur (a design which Freiberg has also employed), a very satisfactory traction upon the prostate and seminal vesicles is obtained (Fig. 883). At this stage of the procedure the apex of the prostate is covered by the posterior layer of Denonvilliers' fascia and it is necessary to divide this (preferably on each side of the median line) to expose the anterior layer, which forms the immediate

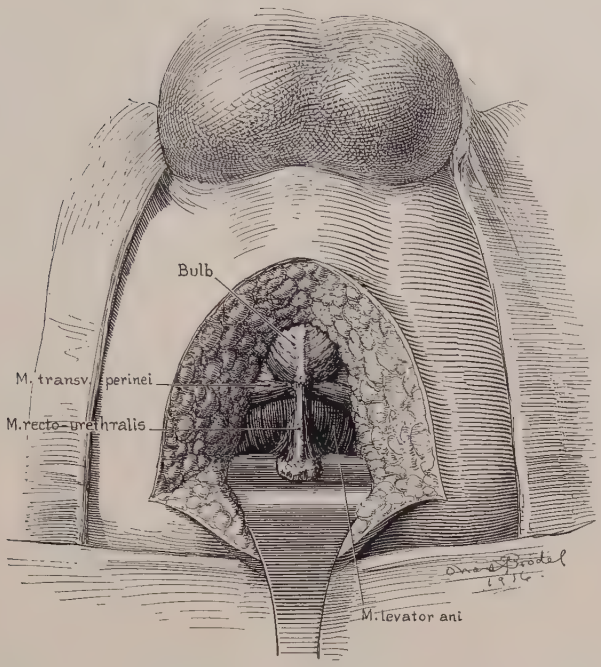


FIG. 880.—Radical operation for tuberculosis of seminal tract: The central perineal tendon has been divided, exposing the recto-urethralis muscle, which is next divided.

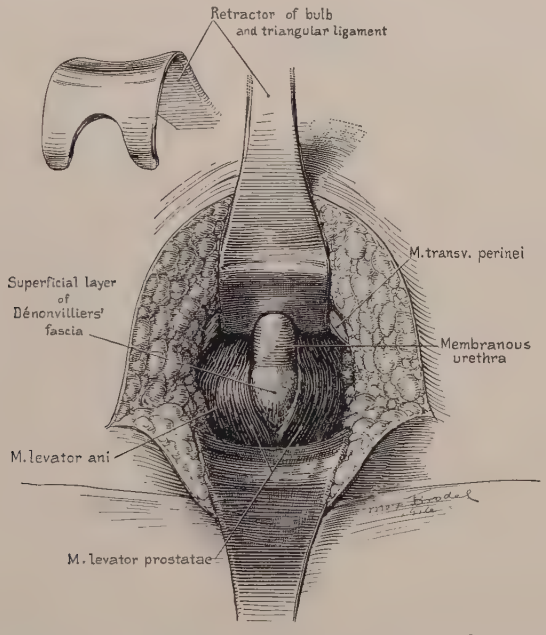


FIG. 881.—Radical operation for tuberculosis of seminal tract: Membranous urethra exposed, but not opened. Posterior layer of Denonvilliers' fascia is seen; apex of prostate partly exposed.

covering of the posterior surface of the prostate. This is easily recognized by its pearly white appearance. By blunt dissection with the handle of the scalpel the layers of Denonvilliers' fascia are rapidly opened up and the whole posterior

surface of the prostate and the adjacent portions of the seminal vesicles exposed, traction at the same time being made with the long tractor in the urethra to draw down the seminal vesicles (Fig. 884). In order to secure a wider and deeper exposure it is generally advisable at this point to incise slightly the levator ani mus-

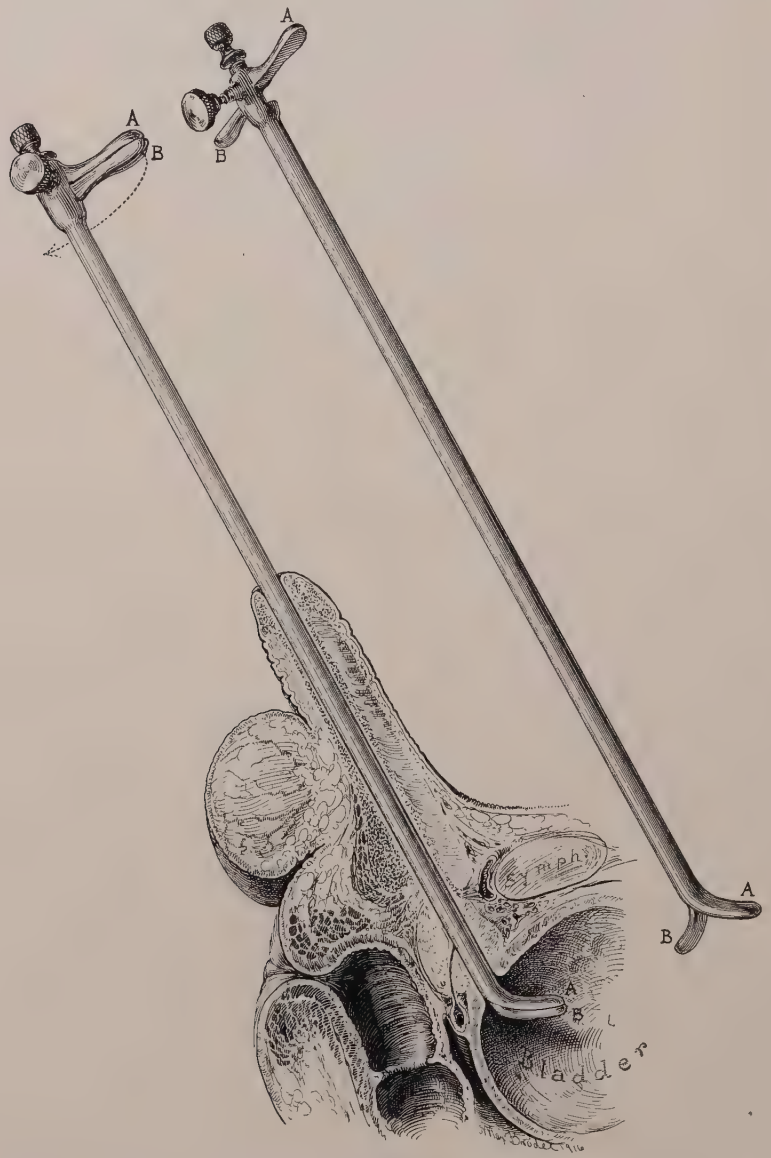


Fig. 882.—Radical operation for tuberculosis of seminal tract: Showing urethral tractor carried into bladder, where it is opened out preparatory to making traction and leverage.

cles and to insert deep narrow retractors at each inferior angle of the wound. At this stage of the operation one finds in the midline the rounded mass of the rectum posteriorly covered by the posterior layer of Denonvilliers' fascia, and between the rectum and the seminal vesicles a soft bulging mass, which is the outer surface of the peritoneum covering the pouch of Douglas. This should be carefully pushed

backward. Until recently blunt dissection was continued so as to open up the space between the peritoneum and the anterior layer of Denonvilliers' fascia covering the seminal vesicles and the vasa deferentia. With the entire posterior surface of the prostate, seminal vesicles, and ampullæ thus exposed to view, careful survey of the situation was made. Although extensively diseased the seminal vesicles often appear fairly healthy, in other cases they may be markedly indurated or

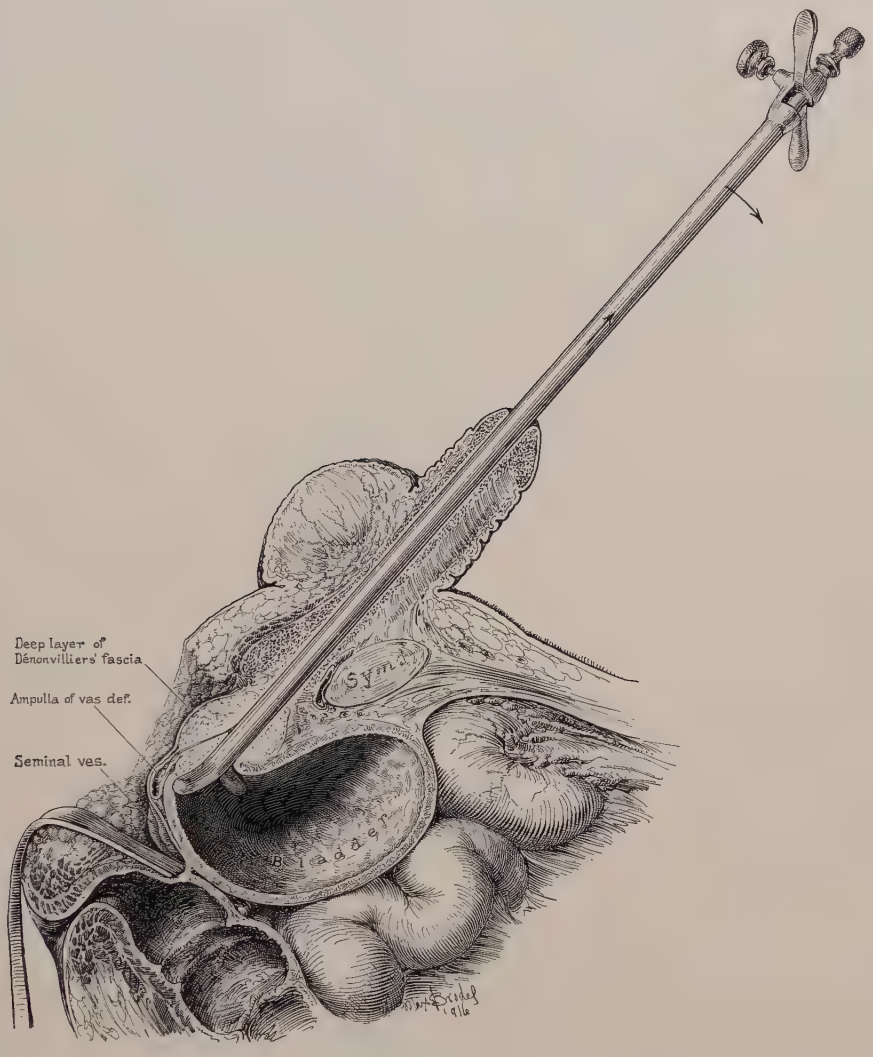


FIG. 883.—Radical operation for tuberculosis of seminal tract: Traction and leverage made, forcing prostate and seminal vesicles into perineal wound.

very adherent and sometimes definitely soft. Bound together as they are by the anterior layer of Denonvilliers' fascia, and often covering and concealing the ampullæ, it is generally difficult at first to locate vesicles and vasa individually.

As it is generally desirable to remove the lateral portions of the prostate along with the seminal vesicles, incisions are made on each side of the urethra about $1\frac{1}{2}$ cm. apart, and going deeply into the prostatic substance, being careful to avoid

the urethra and the bladder. These two incisions were formerly brought together obliquely over the two ejaculatory ducts, as shown in Fig. 884, and from that point the incision carried through the posterior fascia of Denonvilliers in the median line for at least 5 cm. (2 inches). In carrying out the technic as above described we have occasionally opened the peritoneal cavity. To avoid this, as soon as the region

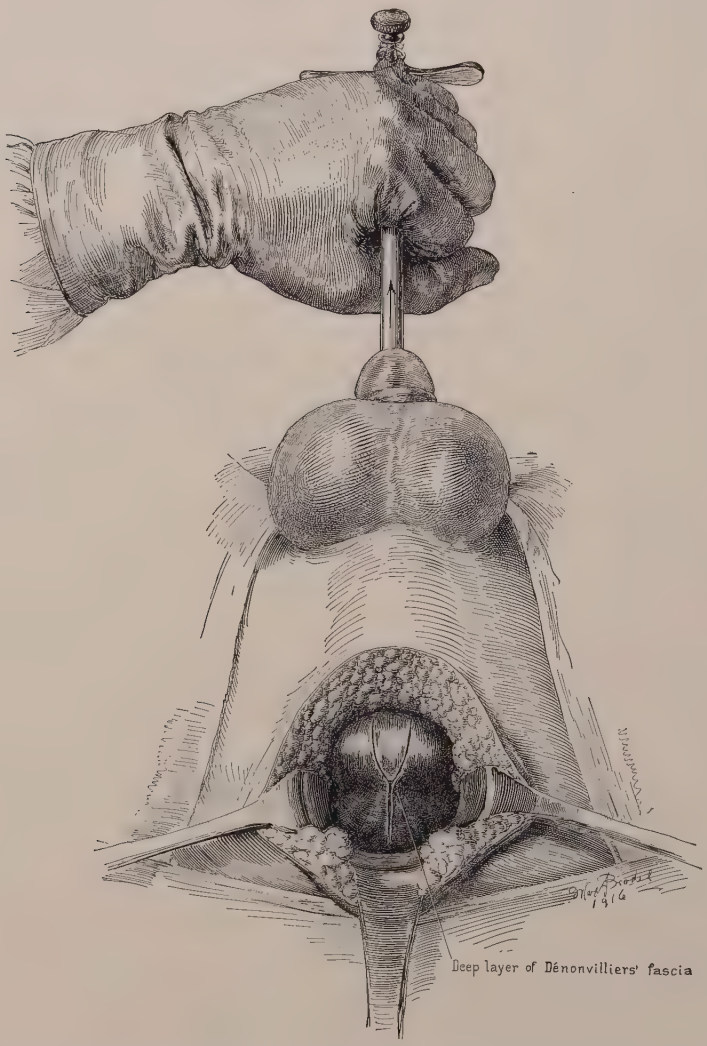


FIG. 884.—Radical operation for tuberculosis of seminal tract: Levators and rectum drawn away, exposing fascia of Denonvilliers. Y-shaped incision through fascia. More recently a transverse incision through fascia at base of seminal vesicles has been employed. (See Fig. 885.)

immediately above the prostate is brought to view we now make an inverted U incision through the anterior layer of Denonvilliers' fascia over the lower portion of each vesicle, as shown in Fig. 885. By blunt dissection (perhaps assisted at first with the blade of the knife) the fascia is stripped up from the posterior surface of vesicles and ampulla as well as from the lateral lobes of the prostate and adjacent lower portions of the vesicles in front.

The inverted U incision, above described, makes it unnecessary to free the whole of Denonvilliers' fascia covering the vesicles posteriorly, avoids hemorrhage, saves time, gives a wider exposure than either a longitudinal or a transverse fascial incision, and absolutely prevents injury of peritoneum or rectum.

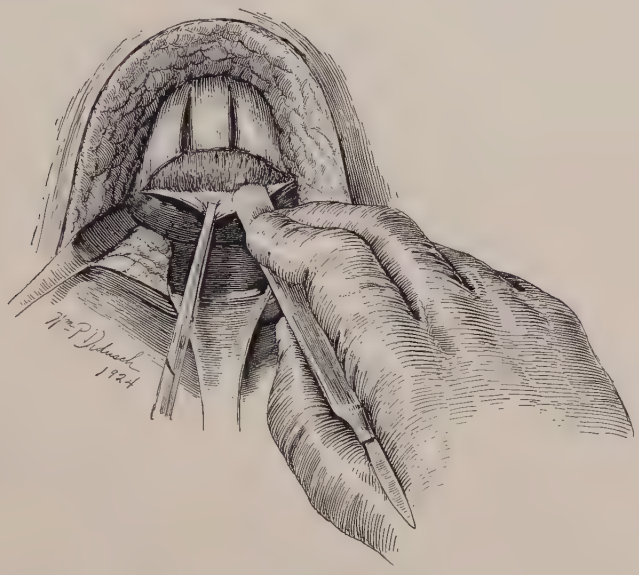


FIG. 885.—Young's radical operation for tuberculosis of seminal tract: Curved incision through fascia at juncture of vesicles with prostate (more recent technic). Elevation of fascia from vesicles.

Blunt dissection should be carried out as deeply as possible on each side, and the long retractors then placed in front of the fascia so as to expose the whole posterior surface of the seminal vesicles (Fig. 886). The next step in the procedure is

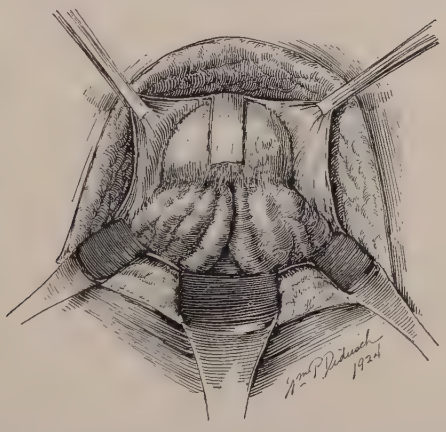


FIG. 886.—Young's radical operation for tuberculosis of seminal tract: The fascia of Denonvilliers has been stripped up from prostate, vesicles, and ampullæ. Ejaculatory bridge preserved. B. U. I. 8398.

usually to isolate the seminal vesicles and vasa deferentia from each other by blunt dissection. This is at times quite difficult, owing to marked adhesions. It is usually possible to separate structures near the midline, but isolation and separation of each vas deferens and seminal vesicle in its upper reaches are often quite difficult.

Owing to adhesions to the bladder sharp dissection may be necessary, but greatest care should be taken to work with the scalpel upon the posterior surface of the vas

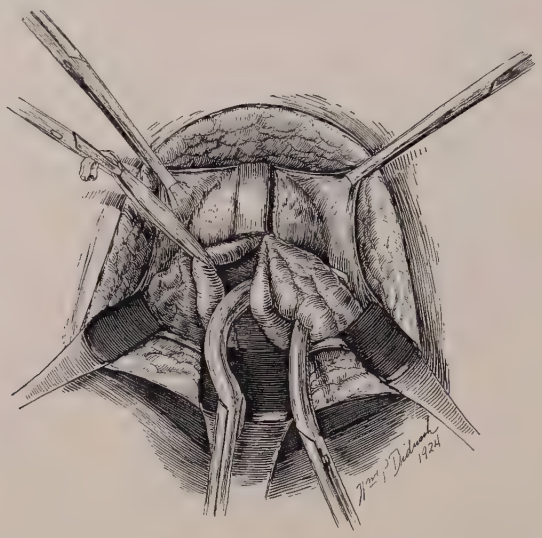


FIG. 887.—Young's radical operation for tuberculosis of seminal tract: Showing separation of seminal vesicles and ampullæ with clamps. Lateral lobes partly enucleated. Floor of urethra and ejaculatory ducts preserved.

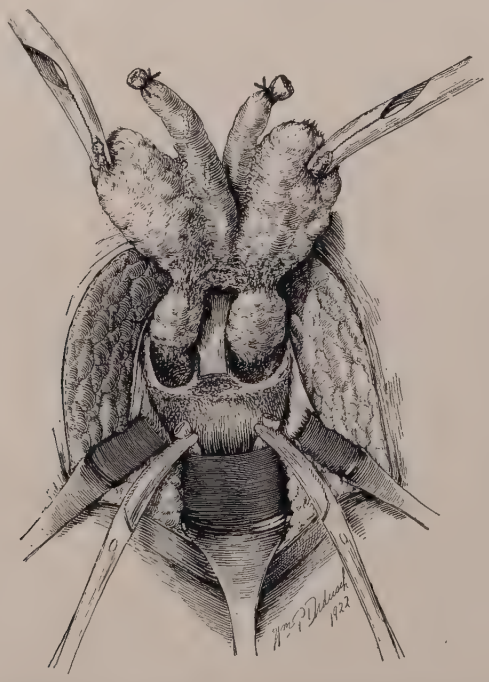


FIG. 888.—Young's radical operation for tuberculosis of seminal tract: Removal of seminal vesicles, ampullæ, and lateral prostatic lobes in one piece. Urethra preserved. Ejaculatory ducts divided. Vasa clamped. B. U. I. 10,180.

or seminal vesicle and not upon the bladder. After the vesicle has been freed in its upper portion a blunt curved clamp can usually be passed between vesicle and

bladder without injury to the bladder, and by to-and-fro motion additional separation of the vesicle obtained (Fig. 887). In some cases, where it is extremely diffiicult to separate the vesicles from the bladder, it may be wise to attack the lateral lobes of the prostate first and beginning the dissection in front to carry it backward. The advantage of this is that the bladder is always in view and can be avoided without difficulty. Ordinarily, however, the vas and vesicles are successfully separated from the bladder on each side, and then the vesicle may be separated from the vas and a tape placed around each for purposes of traction. A clamp should then be placed across the fibrovascular pedicle at the upper end of the seminal vesicle. This should be very carefully ligated with heavy catgut, using transfixion sutures if necessary. Severe hemorrhage may occur if this is not successfully carried out.

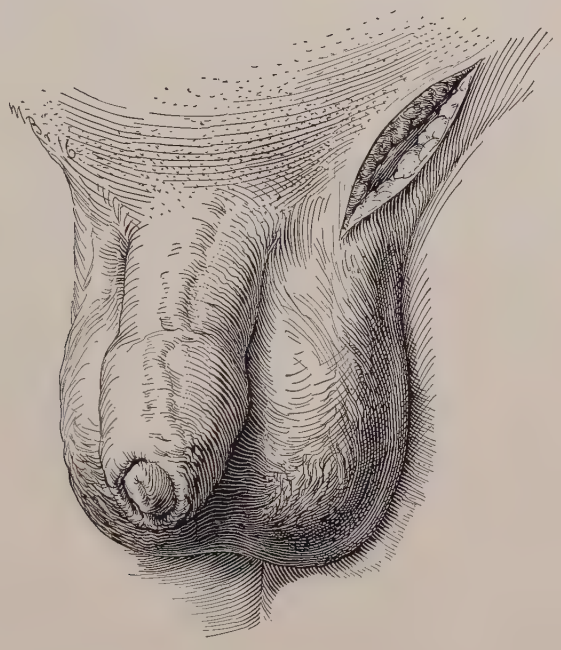


Fig. 889.—Young's radical operation for tuberculosis of seminal tract: The incision preparatory to epididymectomy.

After freeing the tip of the seminal vesicle the vas deferens may then be attacked and isolated by blunt dissection as high up as possible. In so doing the finger passes to the inner side and in front of the ureter which may be indistinctly felt as a fibrous cord. In none of our 25 cases has the urethra been injured nor has it even been visible to the eye. In many cases the vas deferens is so greatly thickened, enlarged and adherent, that it is extremely difficult to separate it from its surrounding adhesions; we should persist, however, until traction shows that it has been properly freed. It may then be clamped doubly and divided. The upper clamp is left *in situ* for subsequent traction (Fig. 888) in a to-and-fro motion to liberate the remaining vas previous to its removal through the groin.

The opposite seminal vesicle and vas deferens are similarly isolated, clamped, and ligated. The operator then proceeds to complete the separation of the anterior portions of the seminal vesicles and vasa from the bladder, being careful in so doing

to remember that it is very easy to injure the bladder. By making the sharp dissection (which is usually necessary) preferably upon the posterior surface of the seminal vesicles, but without opening into them, bladder injury may be avoided. When the prostate is reached, the operator usually shifts his attention to the lateral lobes of the prostate, the capsule of which has already been dissected off.

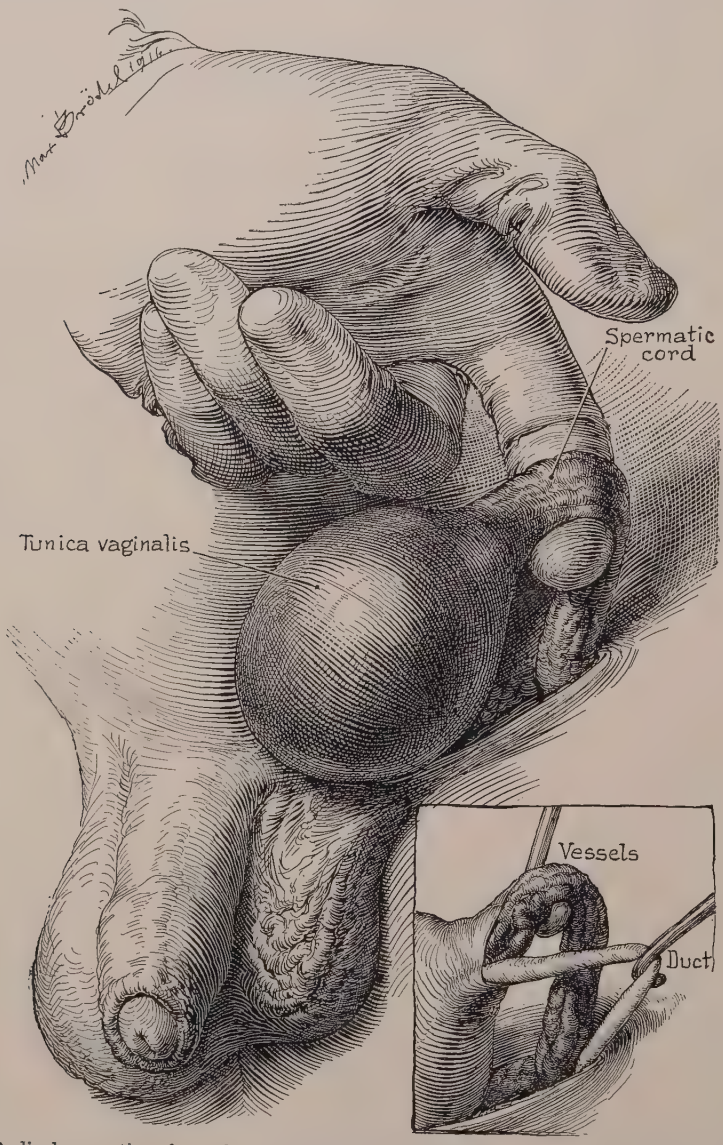


FIG. 890.—Radical operation for tuberculosis of seminal tract: Cord and testicle delivered. Separation of vas from spermatic vessels.

With the knife a deep incision parallel and near to the urethra is made, and by means of a large sharp curet almost all of each lateral lobe is gouged out, carried backward, and removed in continuity with the seminal vesicle to which it is adherent. Sharp dissection is necessary at the vesicoprostatic juncture, and on each side of the median line it is necessary to cut across the ejaculatory ducts at

the upper end of the prostate. The specimen consisting of the lateral lobes of the prostate, portions of the ejaculatory ducts, ampullæ, and seminal vesicles may then be removed in one piece, as shown in Fig. 888.

Inspection of the wound will then show the lateral cavities of the prostate, the cut ends of the ejaculatory ducts, the posterior surface of the bladder intact, and the stumps of the vasa deferentia in the depths of the wound, to which long curved clamps are attached. At this point it is usually wise to insert two narrow drains of iodoformized gauze, but not to close the wound until the operation upon the groin or scrotum has been carried out.

Second Stage of Operation—Epididymectomy and Extraction of Remainder of Vas Through Groin.—Using our special urologic table, the position of the patient is usually not changed for the second stage of the operation, though sometimes

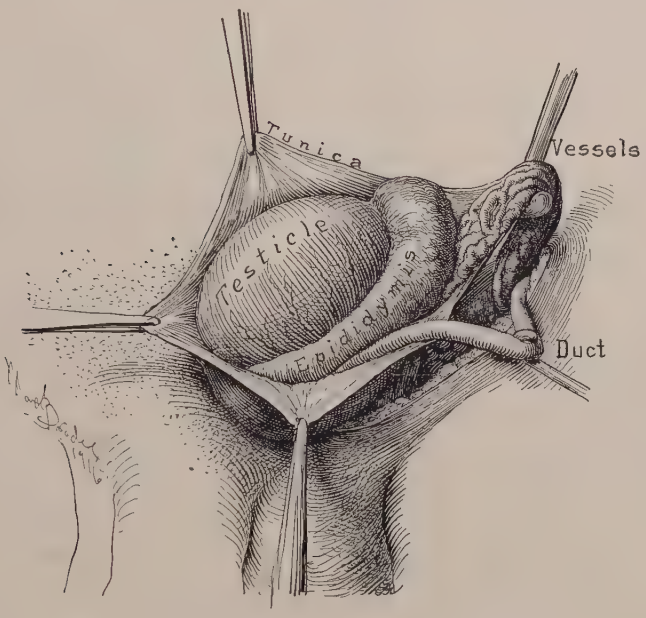


Fig. 891.—Radical operation for tuberculosis of seminal tract: Tunica vaginalis opened after delivery of testicle. Vas separated from veins of cord.

we drop the leg holders and thus get the thighs and knees out of the way, while still making it possible to reach the clamp in the perineal wound.

A high incision in the scrotum (Fig. 889) is usually preferable to a lower scrotal incision unless fistulæ or skin infiltration be present, when a lower scrotal incision with excision of affected portions of the skin should usually be done. It is unnecessary to make the incision in the groin or to open the inguinal canal. After passing through the subcutaneous fascia, the testicle with its sac (dartos) is delivered through the wound by traction on the cord (Fig. 890). The vas deferens is recognized and isolated by sharp or blunt dissection from the veins which lie to its inner side. The tunica vaginalis is opened in the median line and the testis carefully inspected for tuberculosis (Fig. 891). Not infrequently one finds induration in the upper and posterior portions of the testis, but this may simply be due to adhesions to the adjacent tuberculous epididymis. If a large part of the testis is definitely enlarged, indurated, and surely tuberculous, castration should then be carried out,

otherwise epididymectomy. The separation of the epididymis from the testis is usually facilitated by passing a blunt clamp between it and the testis, being careful that the veins are not injured as the clamp emerges at the upper inner aspect of the epididymis. The globus minor of the epididymis is then dissected free from the testis, care being taken to avoid opening the tuberculous epididymis or the substance of the testis. As the dissection proceeds, particular care should be taken not to injure arteries which enter the testis to the inside of the epididymis near the middle. As the dissection proceeds toward the globus major, the veins must be carefully avoided. The globus major, when completely separated, is freed from the testis by means of the electrocautery, it being usually wise to penetrate the testis for a short distance, so as to be sure of destroying any tuberculous material at the testiculo-epididymal juncture. If small areas of tuberculosis

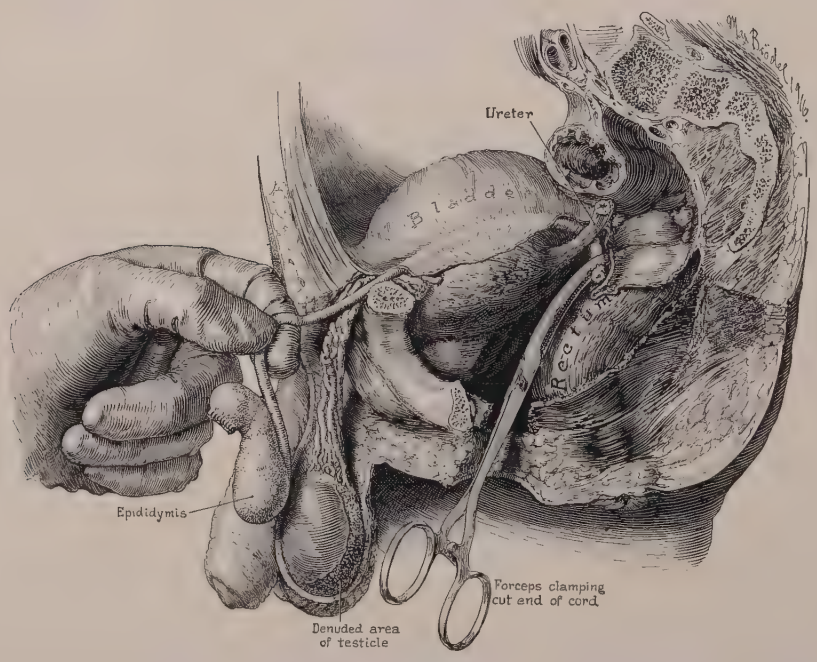


FIG. 892.—Young's radical operation for tuberculosis of seminal tract: Showing Young's method of traction alternating between finger on vas in groin and clamp on deep end of vas in perineal wound, by which vas is freed and then drawn out through the inguinal canal.

are found in the upper portion of the testis, this may be excised with the cautery and in some cases, particularly those in which the other testis has been previously removed, it is better to resect a portion of the testis than to do a second castration.

The epididymis having been freed from testis and veins, the vas is now followed up to the inguinal canal, adherent fascia and vessels being stripped off so as to thoroughly isolate the vas. It is usually not necessary to open the inguinal canal, as the index-finger can follow the vas through the canal and as far as the peritoneum. With the vas thus liberated a to-and-fro traction is begun by means of the clamp attached to its deeper portion, and the vas grasped with gauze between thumb and finger externally, as shown in Fig. 892. In most cases the whole length of the perivesical vas deferens is thus freed very promptly. On removing the clamp

from the lower end, no difficulty is usually experienced in withdrawing the entire remaining vas out through the inguinal canal.

In some instances, however, there are marked adhesions along the posterior surface of the bladder and considerable to-and-fro traction is necessary before the vas is sufficiently freed. Occasionally the deeper portion of the vas breaks off and only a portion is removed through the inguinal canal. In such cases the remaining portion of the vas may give trouble for a time, and it is advisable, therefore, to drain with a small rubber tube through the perineum to the inferior end of the remaining vas segment, and also to insert a small rubber catheter through the inguinal canal so as to drain the anterior end of the vas as well. In 25 cases, this has only been carried out in one, but in a case in which it was not done an abscess in the groin resulted from the stump of the vas which had not been removed.

If the opposite epididymis is involved, complete epididymovasectomy is carried out on that side also. Where no operation is done upon the opposite side

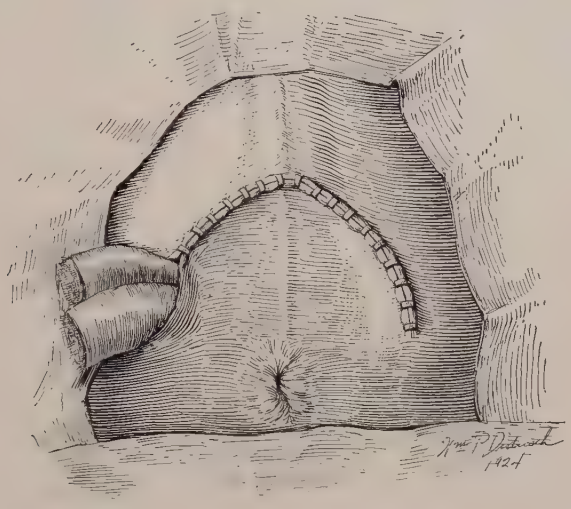


FIG. 893.—Young's radical operation for tuberculosis of seminal tract. Final closure with skin clips; cigarette drain to region of each vesicle.

of the scrotum the retrovesical portion of the vas may be forcibly divulsed and as much removed as will come away with the ampulla. When operation is necessary on both sides of the scrotum it is our practice to have the first assistant operate upon the opposite side simultaneously in order to hasten completion of the operation. The specimens removed in some of our radical operations are shown in Figs. 178 and 180 (Chapter IV).

The scrotal wound is closed with a deep layer of sutures for the fascia, metal clips or continuous silk for the skin. Drainage of the scrotal wound is only supplied in cases in which a tuberculous sinus or an abscess is present or the wound has been soiled with pus during operation. It is rare to have persistent sinuses form in the groin after this procedure.

The perineal wound having been packed with two narrow strips of gauze into the upper deepest portions of the wound and a small rubber tube having been supplied in case a portion of a tuberculous vas remains, the levator ani muscles are brought together with heavy chromic catgut sutures and the skin wound approxi-

mated in front and on one side with metal clips reinforced by stay sutures of heavy catgut, drainage being brought out at the lower angle of the wound on one side (Fig. 893). In most cases the drains are removed in a few days. If a portion of the vas remains, it is well to maintain drainage longer and in such cases the gauze drains are removed in a week and the tube is allowed to stay a few days longer, being treated with injections of 1 per cent. mercurochrome in small amounts several times daily.

Variations in the Radical Operation.—If preoperative examination has failed to reveal any evidence of involvement of the lateral lobes of the prostate and this is confirmed by inspection and palpation at operation, the seminal vesicles and ampullæ are removed but the lateral lobes of the prostate are left untouched. Where only one seminal vesicle, corresponding to the side of the tuberculous epididymis, is involved, one is tempted to leave the opposite vesicle, ampulla, and vas, but in the few cases in which we have done this we have generally regretted it, owing to the development of tuberculosis on the remaining side (seminal vesicle and epididymis). We are, therefore, of the opinion now that seminal vesiculectomy for tuberculosis should always be double and that the vesicles, ampullæ, and as much of the vas deferens as possible should be removed on each side. It also seems probable that in the majority of cases the lateral lobes of the prostate should be removed. We have done this in almost all our cases and the good results obtained seem to indicate that there is no particular reason to avoid operations upon the lateral lobes of the prostate. The prostatic tissue has almost always been found involved, even though it looked healthy at operation. When it is decided not to attack the lateral lobes of the prostate, a single inverted U incision near the base of the prostate through the fascia of Denonvilliers will give a satisfactory exposure of the seminal vesicles.

If the peritoneum is injured, it may be sutured or the aperture packed with iodoform gauze. In the few cases in which this has occurred we have employed both procedures with immediate good results. In no case has there been a tuberculous peritonitis or any other resultant complications. Where the bladder is injured, this should be closed promptly. Injury of the bladder occurs in freeing the anterior surfaces of the seminal vesicles from the posterior surface of the bladder, to which they may be very adherent. By greater care with the use of sharp dissection, injury to the bladder can usually be avoided. It is important to have the tractor so arranged that the blades do not project posteriorly toward the bladder, but are inclined obliquely forward, as in the latest model of our instrument. In no case has the urethra been opened, even though extensive tuberculous lateral lobes of the prostate have been removed. The ejaculatory ducts have frequently been found markedly tuberculous in their terminal portions. We have treated these with pure carbolic. Colston has demonstrated in a case of simple epididymectomy that urine may escape from the urethra, through an ejaculatory duct and vas deferens, out through a fistula in the groin. Bidgood has, therefore, placed a suture ligature of catgut around the ejaculatory ducts after removing the vesicles, with apparent success.

VASOTOMY

The injection of chemicals into the vasa deferentia was popularized by Belfield for the treatment of acute and chronic inflammation of the seminal vesicles. Von Büngner had previously used iodoform glycerin as an injection into the vasa and seminal vesicles following epididymectomy for tuberculosis. Belfield and his pupils

have made numerous reports and the literature now contains many cases in which this method has been employed, apparently with excellent results in the hands of some operators.

The *operative technic* is as follows: The vas is palpated between the finger and thumb and brought up to the surface of the skin in the upper part of the scrotum. A linear incision is made through the skin, subcutaneous fascia, and dartos, a blunt instrument is passed behind the vas deferens, which is brought out through the skin wound and incised. A syringe filled with 2 or 3 c.c. of argyrol, 1 per cent., and provided with a needle of the proper size (preferably with a blunted point) is introduced into the lumen of the vas and the fluid slowly injected (Fig. 894).

x-Ray examinations have shown that the fluid penetrates into the ampulla and also usually backs up into the seminal vesicle from the ejaculatory duct. The vas may be closed with a very fine stitch or simply put back into the wound without closure, the fascia and skin of the scrotum being closed with sutures. This operation may also be carried out on the opposite side. Some operators have left the needle *in situ* for subsequent injections, but we do not recommend this procedure, as the antiseptic which has been injected remains many days and additional injections should rarely be made until after a prolonged intervening

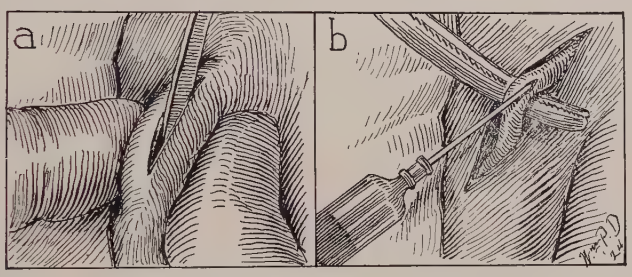


Fig. 894.—Vasotomy: *a*, Skin drawn taut over spermatic cord by pressure between finger and thumb at upper end of scrotum. Skin incision. *b*, Vas isolated from veins, drawn out, punctured with needle previous to injection.

period. Recently 1 per cent. mercurochrome has been used in injecting the vasa through the scrotum, with apparently good results.

SEMINAL VESICULOTOMY AND VESICULECTOMY

In chronic infections of the seminal vesicles, with rheumatism and other distant manifestations of the infection, either drainage or excision of the seminal vesicles may be necessary. Fuller of New York deserves great credit for the work that he did on, this subject comprising great numbers of cases on which he operated. There can be no doubt that operative intervention gives, in some instances, brilliant cures of chronic rheumatism and arthritic infections of a desperate nature and Fuller has recorded many such instances. Abscesses of the seminal vesicles are attacked in the same manner.

The technic of Fuller's operation is as follows: With the patient on his abdomen, the legs hanging over the edge of the table, a wide incision is made in front of and on each side of the anus, the skin, fat, and fascia being divided. By blunt dissection on each side of the rectum the finger passes up by the side of the prostate until the seminal vesicle is reached and carefully palpated. A long scalpel is then introduced by the side of the finger and the surface of the seminal vesicle is

opened fully with the point of the scalpel, which is guided by the adjacent finger. Two or three such incisions may be made so as to secure adequate drainage, after which a long rubber tube is inserted, and fastened in place for several weeks so as to insure continuous effective emptying of the chronic infectious process. As noted here, the central tendon, membranous urethra, and posterior surface of the prostate are not exposed, the operation being essentially a separate operation upon each seminal vesicle and carried out blindly by the finger and scalpel. In rare instances, Dr. Fuller excises a portion of the seminal vesicle by a somewhat enlarged technic, but in the great majority of his cases the operation was carried out as described above and consisted simply in prolonged drainage. His results, however, were often so brilliant and he operated on so many hundreds of cases, apparently without mortality, that his accomplishments should have the recognition which those of a pioneer deserve.

We personally feel, however, that with more modern methods and adequate, long tractors at hand the time for blind surgery upon the seminal vesicles has passed and, therefore, always employ an open technic similar to the one that we have described for tuberculosis of the seminal vesicles.

Seminal Vesiculotomy and Vesiculectomy Under Visual Inspection.—The operation which we carry out is so similar to that with our long urethral tractor for excision of the seminal vesicles in tuberculosis that very little additional comment is necessary. The incision and exposure of the prostate with the assistance of a long tractor in the urethra are identical. When the posterior surface of the seminal vesicle has been brought into view, one can determine whether simple drainage or excision on one or both sides is the operation of choice. If the drainage is done, it may be either by single or multiple incisions or by excision of the posterior surfaces, which better opens up the cells of the vesicles and ampullæ.

If incisions are employed, it is well to open the vesicle longitudinally in two or three parallel lines so as to open up all of the sacculations. The ampulla of the vas should also be widely opened, as not infrequently the infection is more abundant in the ampulla than in the vesicle—almost justifiying Belfield's title of "pus tubes in the male." The same procedure may be carried out on the opposite vesicle and ampulla, but in our experience it is better to excise the whole posterior wall of the seminal vesicles and ampullæ, thus opening widely the sacculations and providing abundant free drainage for a prolonged period. After all these operations it is important to fasten a rubber tube with numerous perforations to the region to be drained on each side. This should not be removed for several weeks, or at least replaced after removal, so that drainage is continuous for a month or so. In the meantime antiseptic treatment should be applied through the tube.

Seminal vesiculectomy for chronic infections is the operation of choice when the metastatic conditions are very severe or desperate in character. Before resorting to operation, however, one should, in view of the remarkable results which have been secured in these cases by mercurochrome, first try this intravenous therapy. We have seen cases, in which no relief followed simple drainage, promptly cured by vesiculectomy. It would, therefore, seem wise to do a radical operation at once in cases where rheumatism or arthritis make the case very serious. The technic is similar to that of operation for the removal of tuberculous vesicles, as previously described. The operator may or may not remove the ampullæ of the vasa. In some cases we have simply removed the vesicles and opened widely the posterior surfaces

of the ampullæ, the object being not to cut off the flow of spermatozoa from the testicles and to interfere less with the sexual function. Though this may be desirable in young men, in older men with very severe arthritic complications the complete removal of vesicles and vasa is indicated, especially if the ampullæ are the seat of extensive inflammatory diseases. It may be stated, however, that removal of both vesicles and ampullæ on both sides does not always interfere with libido, erections, or coitus. The amount of ejaculated fluid is, of course, greatly reduced, but several patients report fairly satisfactory coitus after a radical seminal vesiculectomy and ampullectomy.

Chronic infection of the prostate may make it advisable to open or excise a portion of the lateral lobes of the prostate in these cases. The operator will have to be guided by the condition found on rectal examination before operation or by palpation, and perhaps incision, of the prostatic lobes at operation. A smear can be made from the secretion obtained from the cut surface, and if found to contain pus and bacteria, it will probably be wise to excise a portion of each lateral lobe and to pack the aperture with gauze so as to maintain drainage. Statistics are lacking, however, as to what procedure should be carried out and much will depend upon the severity of the inflammatory lesions in other portions of the body.

Where the condition of the patient is desperate, with endocarditis, arthritis, or chronic rheumatism of a disabling nature, nothing should be left undone to get rid of the chronic infection which is the source of it all. It is not necessary to open the urinary tract, as we have remarked before in describing the radical operation for tuberculosis of the seminal tract. If a severe chronic epididymitis accompanies the seminal vesiculitis, it should be attacked either by incision or excision. If the latter is done it may be wise to remove the entire vas deferens by traction through the groin, after seminal vesiculectomy has been carried out.

Cysts in the region of the seminal vesicles occasionally require operative intervention, as they sometimes reach such large size as to cause disturbance to the vesical and rectal functions. As shown by English, there are several varieties of cysts occurring in the Müllerian ducts or other embryonic rests of the prostatovesicular region. They may be attacked through the perineum with an exposure similar to that for the seminal vesicles or treated through the urethroscope by incision, fulguration, or cauterization.

Cancer of the seminal vesicles is, in our experience, extremely rare except when associated with cancer of the prostate or of the bladder. We have seen a few cases in which the disease may have begun as a cancer of the seminal vesicles, but in all these cases at the time of admission the process was so extensive that radical operation was out of the question.

It seems probable, however, that with more frequent examination early cases of carcinoma of the seminal vesicles should be diagnosed, and if so, radical operation to remove completely the vesicles, vasa, and adjacent tissues ought not be a difficult procedure. The technic of exposure would be similar to that previously described, using the long tractor to draw down the prostate and neck of the bladder and furnish counterpressure for examination. In such cases it may be desirable to remove the adjacent portion of the trigone and even the upper portion of the prostate; and indeed the operator may even find it desirable to carry out our typical radical operation and remove the entire prostate with its capsule, urethra, and most of the trigone along with the seminal vesicles and ampullæ. Whether the extremely

radical or the subradical operation is carried out, excellent functional results should be obtained, as following plastic closure of the defect in the bladder in our radical operation for prostatic cancer. Implantation of radium in such cases and subsequent *x*-ray treatment should also be considered.

Sarcoma of the prostate, or seminal vesicles, as described in the literature, is, in our opinion, in most instances really a sarcoma of the *region* of the seminal vesicles. The disease is retrovesical and involves the prostate later.

We have personally only operated on 1 case of sarcoma and were then able to accomplish little more than partial enucleation of large masses of tumor tissue, leaving much behind at the end of the operation. Recent progress in radium and *x*-ray therapy has done away with the necessity of operations upon sarcomata of this region. We are now able to report 3 cases in which remarkable results have been obtained with both radium and *x*-ray. In all of these cases there has been a complete disappearance of the malignant tumor and apparent restoration for the time being to normal. (See Chapter VIII.)

In a recent article Bumpus[1] mentions 70 cases of sarcoma of the prostate which he had found in the literature, and 5 cases from the Mayo Clinic, which he reported in full. He states that lymphosarcoma, composed almost entirely of the single type of cell, rapidly growing and having little or no connective-tissue stroma, will usually be found as a soft boggy tumor of considerable size. The difficulty of distinguishing such an enlargement from prostatic abscess is illustrated in his third case. The tumor was a rapidly growing lymphosarcoma of the same type as his fifth case, which was described as uniformly enlarged, hard, dense, and adherent. The first case (No. 3) was in a young man, and Bumpus thinks that this is responsible for its softer consistence, whereas the other (Case 5), in a man aged sixty-four, was so hard that it was thought to be carcinoma. Case 4 was a very large soft tumor in a child three years of age and proved to be myxosarcoma. On the other hand, in another case of myxosarcoma in a man past sixty, the rectal examination showed a much firmer tumor.

In Parmenter's series of 59 cases, 20 occurred in the first decade, over twice as many as in any subsequent decade, whereas, in a review of 1000 cases of carcinoma of the prostate seen at the Mayo Clinic, Bumpus found none in men less than forty-two years of age, and in only 4 was it discovered in men less than forty-five. Therefore, he says, any malignant tumor occurring in the prostate before the age of forty may safely be considered as sarcoma. Dr. Bumpus agrees with us in the use of radium and Roentgen ray in these cases, and says that a review of these 3 cases treated with radium and Roentgen ray, in which one patient lived seven and a half years, another three years, and the third is still living after two years, seems to indicate its superiority over attempting surgical removal of sarcomas of the prostate.

[1] Journal of Urology, 1925, xiv, 519–533.

CHAPTER XIX

OPERATIONS ON THE SCROTUM AND SCROTAL CONTENTS

OPERATIONS FOR VARICOCELE

The treatment of varicocele depends upon the condition and the symptoms produced. In many instances the patient is nervous and fearful lest serious injury and impairment of his sexual powers may supervene. Many such cases require no operation and may be assured that they need fear no evil consequences from the presence of the varicocele. The presence of pain in the testicle or along the cord and in the groin may be definite cause for operation, which may be carried out in various ways.

The primary incision may be either over the inguinal canal or lower down through the scrotum. The advantage of going higher up in the groin is that the veins are smaller in amount and perhaps more easily separated from the vas, but the objection is that one encounters more vessels in the skin and subcutaneous vessels which require ligatures.

We have usually preferred an incision which is made in the upper part of the scrotum and reaches upward to the lower part of the inguinal canal, this incision being 3 to 5 cm. in length, along the course of the veins which are held between the thumb and finger so as to draw the skin tightly upon them (Fig. 895, *a*). After dividing the subcutaneous fascia, the dartos covering the cord can usually be drawn up into the wound and, if desired, the scrotal contents can be pulled and pushed out through the wound for examination and study.

Having exposed the entire cord (Fig. 895, *b*), an incision is made in the dartos, and the cremaster and several delicate layers of fascia are divided before the veins and vas are reached (Fig. 895, *c*). The artery of the vas and one or two small veins should be isolated with the vas (Fig. 895, *d*), and it is then quite safe to remove the remainder of the veins from the cord. These should be clamped and ligated with transfixion sutures, which should be double above and below so as to insure against any hemorrhage. It is well to excise a portion of the veins, especially if they are very redundant; sometimes 2 or 3 inches are thus removed. The stumps are fastened together with sutures, so as to lift up and support the testicle (Fig. 895, *e*).

Redundancy of the scrotum usually becomes much less after operation and only in rare instances should ablation of the scrotum be carried out. Those cases in which we have done it have been in patients who were greatly concerned over the length and size of the scrotum and in which the great length seemed to produce discomfort. After returning the testicle and cord, the dartos is then closed with a continuous fine catgut suture, the subcutaneous tissues are also drawn together with a continuous catgut and the skin closed with either clips, catgut, or silk, as one may prefer. Drainage is not employed. After operation the testicle should be kept elevated, and if the reaction is very marked, ice-packs may be applied. The patient should be kept in bed for about a week.

Complications.—The most serious immediate complication is hemorrhage, which

is due to the faulty ligature of one or more vessels. A huge hematoma may result which requires a secondary operation and removal of the clot. Remote results are atrophy of the testicle and hydrocele. The former is due to inadequate blood-

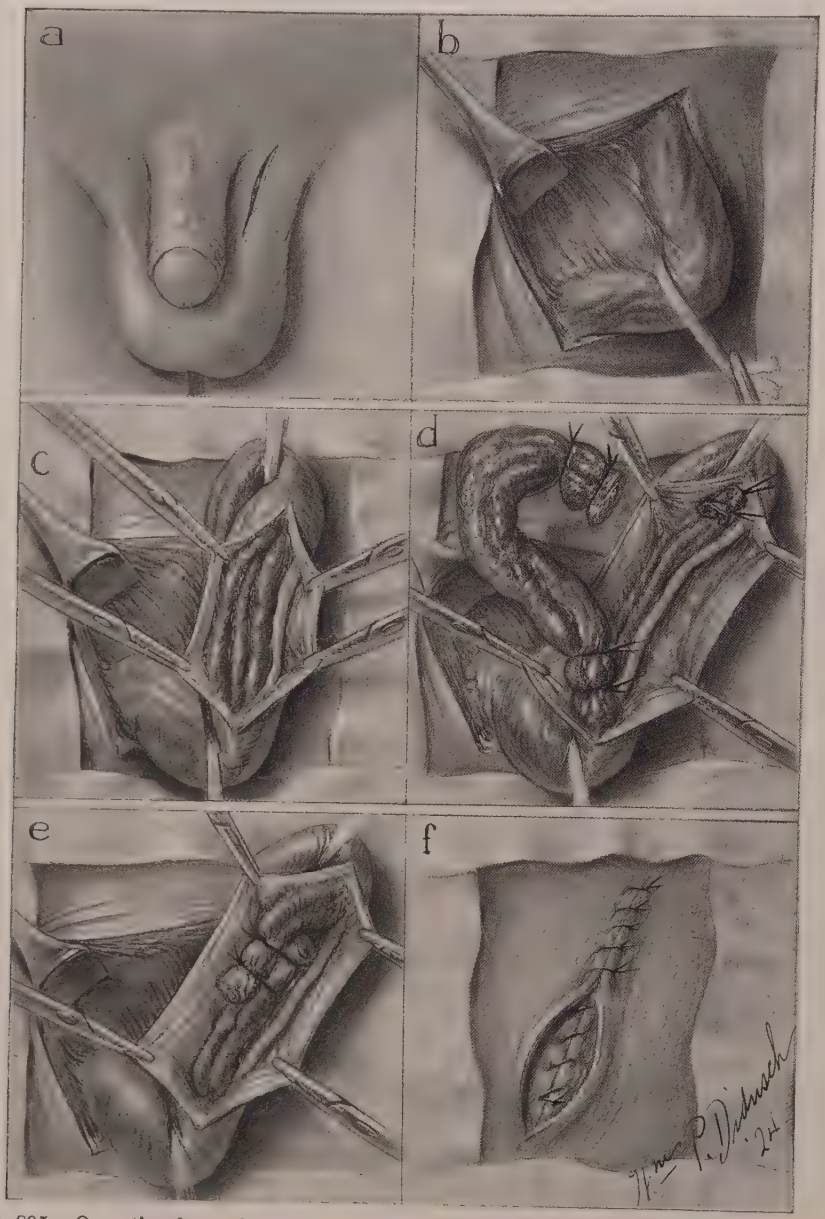


Fig. 895.—Operation for varicocele: *a*, High scrotal incision. *b*, Cord separated and drawn out. *c*, Covering of cord (dartos) opened, exposing veins and vas. *d*, Resection and removal of redundant veins. Double ligature of stump with catgut. Veins and artery of vas preserved. *e*, Ends of veins bound together to elevate and support testes. *f*, Closure of dartos and then of skin.

supply from injury of the artery or veins of the vas, which should be carefully preserved at operation. The cause of hydrocele, which is not infrequent, is difficult to explain. It may be due to inadequate blood-supply or to traumatism at

operation. The frequency of hydrocele has caused some surgeons to advise opening the tunica vaginalis, everting and suturing the cut edges behind the epididymis.

OPERATIONS FOR HYDROCELE AND HEMATOCELE

The treatment of hydrocele is entirely operative and may be either palliative or radical. The palliative operation consists in aspiration or tapping the contents of the hydrocele sac. After locating the position of the testis and hydrocele by grasping it from behind between the thumb and fingers of one hand, a medium sized trocar is plunged quickly into the sac. By holding the trocar at a point fairly close to its sharp end one avoids introducing the instrument too deeply and consequent injury to the testicle. The fluid may be collected in a sterile flask as

FIG. 896.—*x*-Ray showing very large hydrocele with calcified walls. Successfully removed at operation. B. U. I. *x*-Ray 5743.

it gives an excellent culture-medium for gonococci. After the sac has been completely evacuated, collodion dressing may be applied to the puncture wound. The operation of tapping is applicable in old men or where the patient is unable to enter the hospital for a radical operation.

The use of drugs such as tincture of iodin, carbolic acid, etc., to cause obliteration of the sac has been abandoned. Serious results, including considerable pain, have frequently resulted from these methods and recurrence of the hydrocele has rarely been prevented.

Radical Operation.—This may be done either under local or general anesthesia. We prefer an incision through the upper part of the scrotum rather than the groin. The tunica vaginalis is exposed and the testicle, cord, and their coverings are freed

from surrounding adhesions and delivered through the wound upon the surface. The operative technic may be either incision and simple eversion of the sac—Andrews' "bottle" operation—or excision and eversion—Winklemann's operation. In Andrews' operation a very short incision is made in the tunica vaginalis and the testicle extruded through this opening. The sac is then drawn inside out and left without suture, or the opening may be closed to prevent the testicle getting back into the tunica vaginalis. The testicle and sac are then returned to the scrotum and the wound closed.

Excision and eversion of the sac with suture behind the epididymis is, in our opinion, the method of choice, and particularly in large hydroceles and those with thick sacs. The main objection is that frequently considerable hemorrhage is encountered and numerous vessels have to be ligated. It is very important that complete hemostasis should be obtained. After freeing the parietal layer of the tunica vaginalis, the sac is cut away at a point within $\frac{1}{2}$ inch of its visceral insertion on all sides and the two cut edges of the parietal stump are fastened behind the epididymis with a continuous catgut suture.

At the upper end we usually place a stitch through the fascia of the cord so as to hold the upper portion of the everted sac in the proper position and prevent reinversion. The testicle should be carefully examined for adhesions between it and the epididymis and for small cyst-like processes which sometimes lie between the epididymis and the testicle. These, if present, should be thoroughly opened and evacuated. Before restoring the testicle and cord into the scrotum great care should be taken to see that all bleeding points have been stopped. The wound is closed without drainage, the fascia and skin in separate layers. The testicle is elevated and a snug bandage applied.

Complications.—Hemorrhage is the most serious complication and should be provided against by careful attention to hemostasis. A large collection of blood may require subsequent operation and removal. Atrophy of the testicle may occur, but is generally due to unnecessary injury to the vessels.

Results.—According to H. L. Sanford, relapses occur in only 5 per cent. of the cases on whom a radical operation had been performed and who had been carefully examined. No statistics are at hand to show the comparative value of simple eversion and radical excision.

Hematoceles, either acute or chronic, may sometimes be cured by simple aspiration. In some acute cases the blood-clot is so extensive as to require operative removal. In chronic cases one often finds that complete excision of the sac may be required. Where the testicle has been completely destroyed or atrophied it is usually simpler to remove the testicle.

VASOSTOMY

This operation, which has been described under the treatment of diseases of the seminal vesicles, consists in exposing the vas through a small incision in the upper part of the scrotum and the injection of antiseptic solutions through the lumen of the vas. The spermatic cord is isolated, drawn into the wound, and the vas isolated. A tape is then passed around the vas, which is thus put on tension. A hypodermic needle can then be introduced without difficulty into the lumen (Fig. 894). Some prefer to incise the vas before introducing the needle. A horsehair is often employed to determine whether the vas is patent. This may be introduced through

the needle. A better method is to inject a 2 per cent. solution of methylene-blue, which will emerge from a catheter in the prostatic urethra if the duct is patent. As a matter of fact, sterile water may be injected. If it goes in freely the vas is patent. We usually determine patency of the ducts by injection of the ejaculatory ducts through an endoscope. The wound may be closed or left open for subsequent treatment through the needle left *in situ*.

The ultimate results of vasostomy upon the lumen of the vas have never been satisfactorily settled. It is claimed by some that no occlusion occurs even at the site of injection, but recent work by Lespinasse and Brams show conclusively that apparently bland antiseptics lead to extensive changes in the epithelium, sometimes to stricture formation or complete obliteration of the vas. It is, therefore, generally thought that the procedure may sometimes not be entirely harmless and should probably only be used when seriously indicated. (See Chapter III.)

OPERATIONS ON THE SPERMATIC CORD

Spermatocele.—Small cysts are of little import, and need neither aspiration nor excision. As a rule, they remain stationary and cause no discomfort. Larger cysts and those increasing in size, especially if associated with pain, may require operation. In cases where they project into the cavity of the tunica vaginalis, the latter must be opened. In other cases where they are extravaginal, they can be easily isolated and enucleated without opening the tunica vaginalis. They usually spring from the globus major of the epididymis and care should be taken not to injure the tubules, but the sac wall must be completely removed.

Cysts, hydroceles, or solid tumors of the cord may be sufficiently large and painful to require operation, which consists in simple excision with due care not to injure important structures. In the case of hydrocele of the cord, there may be an accompanying partial congenital hernia, and, if so, this should receive proper radical attention.

EPIDIDYMOTOMY

This operation has, in recent years, had a wide usage in acute epididymitis, generally of gonorrheal origin. The recent interest has come through papers by F. R. Hagner, and the literature is now sufficiently complete to show that the operation is of distinct value.

Hagner's technic is as follows: An incision is made through the skin over the point of juncture between the swollen epididymis and testicle, 6 to 10 cm. in length, and includes the skin, fascia, and tunica vaginalis, which is opened longitudinally at the juncture of the epididymis and testicle. "The testicle with its adnexa is delivered from the tunica vaginalis and enveloped in warm towels. The epididymis is found, examined, and multiple punctures made through its fibrous covering with a small tenotome, especially for those portions where the enlargement and thickening are greatest. The knife is continued deep enough to penetrate the thickened fibrous capsule and enter the infiltrated tissue. When the knife is through the thickened covering of the epididymis, a marked lessening of the resistance will be felt. If pus is seen to escape from any of the punctures, the opening is enlarged and a small probe inserted in the direction from which the pus flows. By this method I believe there is less danger of injuring the tubes of the epididymis than by cutting with the knife. The pus is evacuated and a fine-pointed syringe is used to wash out the cavity. The testicle is then restored to its normal position, the tunica

vaginalis washed out, and lightly closed with a running catgut suture. The skin is closed with a cigarette drain in the lower angle of the wound."

Hagner claims for this operation more rapid recovery, almost immediate relief of pain, less frequent obliteration of the tubules of the epididymis, and, consequently, less frequent sterility. In our work we have followed a much less radical course in the treatment of acute epididymitis, both of gonorrheal and non-gonorrheal origin. In our experience, the epididymitis almost always disappears under local treatment—rest in bed, ice-packs, etc. In rare cases have we found it desirable to carry out epididymotomy in the gonorrheal infections. In non-gonorrheal infections, particularly those following urethral instrumentation, etc., elevation and application of ice are all that is necessary in almost all cases. Where the swelling is very large and does not respond to local treatment, and particularly where areas of softening appear beneath the surface of the scrotal skin, incision and drainage is carried out—generally two or more punctures being made in order to secure through-and-through drainage by means of small rubber tubes. It is important that the incision should be small so as to prevent evisceration of testicular substance.

Acute epididymitis has also been treated by direct injection of antiseptics into the swollen epididymis. During the war we saw numerous cases thus treated by Luys, by injections of electrargol. We have also employed a 1 per cent. solution of mercurochrome in a similar way with apparent improvement. The method, however, has not yet been fairly tested. The intravenous use of antiseptics for local infections of the epididymis, as in infections of other organs, has been reported by several observers, and the striking results which have been described certainly justify a more extensive trial of mercurochrome. In cases in which we have employed it, apparently immediate beneficial results were obtained.

EPIDIDYMOVASOSTOMY

The following description of the operation of epididymovasostomy and of the results to be expected therefrom has been contributed by Dr. Francis R. Hagner.

The subject of sterility, whether it is in the male or female, is of such importance both to the family and the state, that it has received the attentive consideration of both gynecologists and genito-urinary surgeons. It is only in recent years that the male member of the union has been carefully studied. Before this time the female received almost the entire attention of the profession. The operative treatment of anastomosis of the vas and the head of the epididymis, as reported by Martin of Philadelphia, gave an impetus to the consideration of the male as a factor in childless marriages. We have had patients where the woman has been subjected to all forms of treatment and operations—where careful examination proved not the woman but the man to be the sterile party, and after operative treatment of him and the return of the spermatozoa, from 1 to 5 children have blessed a union that before had been fruitless.

In our own experience we have never seen a patient who was sterile from gonorrheal epididymitis, who had impotence. From the records we have been able to find the frequency of childless marriages caused by the male is about 1 in 6. However, some give a higher percentage. Gross, in 192 cases, found the male deficient in 18 per cent. (Forty-five per cent. of the soldiers in the German Army who had had bilateral gonorrheal epididymitis were sterile.)

Everyone realizes that there are other causes of sterility than gonorrheal epididymitis. We have taken up this side of the question in a paper in 1910, and will not mention them further than to say that in gumma of the testicle, even where there is enormous enlargement of both testicles, these patients have not been sterile after treatment. One case in mind occurred sixteen years ago. He had bilateral gumma, making a mass almost as large as a man's head, which cleared up following treatment. An examination following the disappearance of the gumma showed normal spermatozoa and he has since had 7 children.

From our own experience, we can say that bilateral gonorrheal epididymitis is surely the principal cause of sterility in men. Statistics show that traumatic epididymitis, unless very severe, rarely leads to sterility. Orchitis, probably rarely, if ever, occurs in gonorrheal infection. We say this from our experiences in the operative treatment of gonorrheal epididymitis, where, in a series of con-

FIG. 897.—*a*, Showing incision of epididymis opened out and tubules cut across; the vas has been opened longitudinally, and a silkworm-gut suture has been introduced into the lumen of the vas; *b*, showing manner of placing silver wire sutures for anastomosis of vas to epididymis in which the sutures are placed deeply so as to draw cut end of tubules into lumen of vas; *c*, epididymovasostomy completed.

siderably over 200, we have never found evidence of involvement of the testicle itself, the epididymis and tunica vaginalis seeming to bear the brunt of this infection.

Technic.—In our earlier cases we followed the technic devised by Martin, but of later years we have felt it was better to open the tunica vaginalis, exposing the entire epididymis, as from this approach we are better able, on inspection, to pick out the portion of the globus major richest in tubules, thereby facilitating the discovery of the portion that may contain live spermatozoa. On opening the vas we used to inject argyrol to be sure that the vas was patulous. We have discontinued this technic, as we feel it is important to keep all foreign substances that might tend to cause cicatrization away from the field of operation. We now use the finest tear-duct probe to be sure we are in the lumen, following this with a smooth strand of silkworm gut, which can, in the unobstructed vas, be passed from

16 to 20 cm. When we have done this we feel reasonably sure that the vas is patulous. If it is obstructed beyond this point, there is no hope of an operative cure. After this examination has been made, we pick out a likely looking place in the epididymis, cutting out an elliptical piece (Fig. 897, *a*). If live spermatozoa are present, a milky fluid is usually obtained as soon as the section is removed. The fluid is at once examined on a warm slide, the presence and motility of the spermatozoa being noted. If no spermatozoa are found, this incision is closed with a catgut suture; another place is selected and the same procedure is followed.

We have tried several types of sutures, very fine silkworm gut, and very fine silver wire. Our only successful cases are those in which we used the silver wire. We cannot explain this unless there is less tissue reaction with silver wire than with the other sutures.

Nearly all of our operations have been done by lateral anastomosis except a few rather atypical cases to be mentioned later. Sometimes we find occlusion of the vas at the first incision and by going further up the vas we are able to get above this obstruction. Care is exercised to cut only into the lumen of the vas, as it is very easy in making this incision to cut through the entire diameter of the tube.

We place the first suture at the distal end of the incision in the vas, taking a good heavy bite, as this is the anchoring suture for the operation and the obstruction is beyond this point. It is then anchored firmly in the lower end of the elliptical incision in the epididymis. Two lateral sutures are then placed to take a fairly heavy bite and include some of the cut tubules (if only the fibrous covering of the epididymis is taken up the cut tubules drop back when the anastomosis is made). The suture is then passed through the cut edges of the vas, taking just enough tissue to approximate the edges. The last suture is then passed in the same way through the upper end of the incision in the vas, being carefully placed so as not to occlude the lumen (Fig. 897, *b*, *c*). The anastomosis is then complete.

We can tell sometimes by examination before operation if a case is inoperable. Such cases on palpation of the vas show distinct beading. These are nearly always occluded and therefore inoperable as regards cure.

We all know in operating upon a spermatocele that unless we remove every part of the sac, which means the removal of the small duct that leads into the cyst, we are liable to a recurrence of the spermatocele. It is probable that this same condition obtains in the cases where we get a cure, namely, that a sinus is formed between the incised vas and one or more tubules in the epididymis, that acts in the same way as the duct that leads to a spermatocele.

A failure at one time, if the vas is patulous, is no contraindication to a second operation, as in some of our most successful cases we have had a failure the first time, with successful outcome at the second operation. The time of appearance of the spermatozoa varies. We have had patients who have had actively motile spermatozoa one month ofter operation, others varying from one month to one year. We do not re-operate on these cases under one year as we have had successes that did not manifest themselves until eight or nine months after operation. In one of these cases the first evidence of cure that the patient had was that his wife became pregnant. He was in a rather unhappy frame of mind until we found he had thousands of spermatozoa.

Before operating we have made repeated examinations for spermatozoa, or repeated examinations have been made by the surgeon referring the case, that were

negative. Some have been sent to us for sterility who were not sterile, so we feel we have to be careful in diagnosing sterility where too frequent demands have been made on the secretion just before examination.

We have not tried the method advanced by Lespinasse of dissecting out a single tubule and implanting it with removable suture. Of course, both ends of the tubule have to be planted, otherwise we would not know which was the efferent or which the afferent end, as the mere presence of spermatozoa would not tell us this. It seems to us that there is a better chance of a sinus between the vas and the epididymis forming, where we have dozens of tubules cut across than if we rely on only one. The advisability has occurred to us of leaving for a short time a piece of wire or silkworm gut in the vas that could be removed in a few days after operation, but any foreign material of this kind tends to make for the formation of cicatricial tissue at the point where we want to minimize its occurrence, and it is probably the slight reaction that the tissues have to a very fine silver wire (which has been proved experimentally) which makes for the success of this operation. It is most important to control all bleeding before making the anastomosis. We have always done a bilateral operation, as this does not interfere with a subsequent operation if a failure occurs.

We are giving a report on only 21 cases, as our records for five years were destroyed in a fire in the record room at the Hospital, and we are not able to get accurate data for this period. As near as we can estimate we have operated on from 38 to 40 patients. Of the 21 reported, there have been 28 operations—7 were reoperated on account of initial failure. Of this number, 3 were cured by the second operation where we failed in the first. We have had 2 patients in whom we found in the epididymis of one side active spermatozoa with an occlusion of the vas on this side, the vas appearing as only a fibrous cord. On the opposite we found no spermatozoa in the epididymis, but the vas was patulous. A crossed anastomosis was done, that is, the patulous vas was brought through the scrotal septum, and anastomosed to the epididymis that contained live spermatozoa. We have been very anxious to obtain a success in this type but, unfortunately, both failed of cure.

We have had one very interesting case in which one side showed no spermatozoa in the epididymis, while on the opposite side the globus major was replaced by a small spermatocele. An anastomosis was made between the vas and the spermatocele. This patient had live spermatozoa within six weeks of the operation. The last report was six weeks later and pregnancy had not yet occurred.

We have made anastomosis directly into the testicle—no result.

Total number reported, 21.

Three patients had either double occlusion of the vas or else bilateral absence of spermatozoa in the epididymis; 14 per cent. of 21.

Eight patients in which no occlusion was found, and in which active spermatozoa were found, failed of cure. This includes 2 crossed anastomosis cases. Thirty-eight per cent.

One patient in which result is unobtainable.

One patient too recently operated on to be reported.

Eight cured. Thirty-eight per cent. of total number reported.

If we eliminate from this reckoning the 3 patients discovered to be inoperable at exploratory operation by reason of occlusion of the vas or absence of spermatozoa in the epididymis, it shows 50 per cent. cured.

Five of the eight operative cures begat one or more children.

The operation, while tedious, is not dangerous to life, although we have always used a general anesthetic. It cannot compromise the function of an organ that has already proved functionless. The only chance for recovery of a patient with sterility due to occlusion of the epididymis is operation to overcome that occlusion.

EPIDIDYMECTOMY

This operation has been described at length in conjunction with the radical operation for tuberculosis of the seminal vesicles. Epididymectomy may occasionally be necessary in cases of chronic infections of the epididymis or painful indurations of long standing. Occasionally, chronic fistulæ may extend into and involve the epididymis to such an extent that epididymectomy is indicated. The operation is practically identical in every way with that previously described (Figs. 889–891). It consists in a careful dissection of the epididymis from the testicle and from the veins and arteries supplying the testicle. The tunica vaginalis is always opened and generally partially excised and the remainder everted and sutured behind the testicle to avoid hydrocele. The vas may be followed to any extent desired and, if abscess of the seminal vesicle coexists, injection of the vas may be done before it is ligated.

RADICAL OPERATION FOR MALIGNANT TUMOR OF TESTIS

Castration.—The patient is placed on his back with the lumbar region elevated upon a cushion or kidney elevator. The spermatic cord is exposed through an inguinal incision which extends well down over the scrotum. The cord is freed from its attachments, being careful not to go through the dartos, and brought up into the wound where it is clamped, divided with cautery, and ligated (Fig. 898). The testicular tumor is then drawn up through the wound, care being taken not to penetrate the dartal coverings. The specimen is then turned over to a pathologist who makes an incision at once in order to prove that the diagnosis of tumor is correct.

Hinman has discovered 4 cases treated by radical operation in which subsequent study of the specimens showed that they were tuberculous. These serious mistakes should be prevented by always examining the specimen before carrying out the radical operation.

Having determined that we are dealing with a malignant tumor, the incision for removal of retroperitoneal glands is then made. In most cases the incision employed has been one extending from the upper angle of the inguinal incision upward and outward to the twelfth rib, which it then parallels for a short distance. The muscle and fascia are divided in the line of this skin incision down to the peritoneum, which is then stripped up from the iliac fossa and the muscles of the back until the large abdominal vessels are reached. This incision is shown in Fig. 900, and has been employed in most of our cases. It furnishes a splendid exposure of the pelvis and lower portion of the lumbar region, but the upper part of the operation in the region of the kidney and its pedicle is deep and difficult. On this account, in the last two operations, we have employed the incision shown in Fig. 899. As shown here, it does not connect up with the incision in the groin, but extends from the median line of the abdomen at a point about 2 inches below the umbilicus, obliquely upward and outward to the tip of the eleventh rib. If, as the

operation proceeds, more room is required, the incision is carried beneath and parallel to the eleventh rib.

The skin, fat, and superficial fascia are divided and a good exposure of the fascia of the external oblique and also the rectus muscle is obtained. By means of a gauze sponge the fat is stripped backward on each side.

Commencing at the outer angle the incision is made through the fascia and three abdominal muscles. When the border of the rectus muscle is reached the

FIG. 898.—Radical operation for tumor of testis, which has been delivered, vas separated from veins, and both ligated separately. The veins are being divided with electrocautery. Vas left intact for more complete removal extraperitoneally. B. U. I. 11,522.

incision is carried simply through the external fascia of the rectus, the muscle not being divided. Having incised the transversalis fascia, the outer layer of peritoneum is then exposed, and by blunt dissection rapidly separated from the lateral and dorsal muscles and the iliac fossa, until the vena cava and aorta are exposed. The spermatic vessels and lymphatics strip up with the peritoneum, but the lymphatic glands remain attached posteriorly. Isolating the spermatic vessels from the peritoneum by blunt dissection at the lower angle of the wound, one follows them downward beneath the bridge of skin and muscle, which separates the two

wounds until the internal abdominal ring is reached. By making traction upon the cord it is then easily delivered into the upper wound. At a point 2 or 3 inches from its lower end (point of division) the vas will be seen leaving the veins and taking a backward course toward the bladder. We usually follow it for a short distance, ligate, and divide it. Lines of fibrofatty tissue extending from the cord toward the brim of the pelvis and iliac vessels are seen, generally two or three in number. It is wise to follow and remove them well within the pelvis. The line of lymphatics which leads toward the promontory of the sacrum is very important because metastatic glands are often found between or in front of the iliac vessels. A short distance above this point other glands are found along the front surface of the vena cava on the right or of the aorta on the left side, and from here upward

Fig. 899.—Radical operation for tumor of testis: Abdominal incision designed to avoid important nerves and give adequate exposure for deep retroperitoneal dissection of glands. Separate scrotal incision through which tumor has been removed.

one frequently finds the lymphatics and glands lying upon or even between the great vessels. Glands are also found in front of and behind the vascular pedicle of the kidney, from which region we have frequently removed them. Occasionally, a line of lymphatics or fibrofatty tissue runs out to the lower pole of the kidney. We have frequently followed this and removed it, but have never been certain that it contained glandular tissue.

In carrying out this incision, the ureter is isolated from the kidney to the pelvic brim. We have never found it adherent to the lymphatics.

On the right side the spermatic vein enters the vena cava; on the left side, the renal vein. No difficulty is experienced in ligating the spermatic artery which comes off from the aorta just below the renal vessels on both sides.

Not infrequently the glands are very adherent to the great vessels, and ex-

treme care is necessary in their removal. In one case we have found them so densely adherent as to make it impossible to remove them. In these cases, we believe, the vessel walls are definitely involved. In one of our cases the mass of glands removed was very large, as shown in the accompanying illustrations (Figs. 900, 901).

When one reaches the pedicle of the kidney a very wide upward retraction is necessary in order to get a good exposure (Fig. 900). It is very important to remove the glands in front of and behind the renal vein, and also those that are

Fig. 900.—Extraperitoneal dissection of glands and lymphatics from region of great blood-vessels, lower pole of kidney, and renal pedicle. Patient still alive and well eighteen months later. B. U. I. 11,522.

found along the front of the great vessels, and sometimes between them. On the left side the operation is more difficult than on the right, owing to the more marked fibrous adhesions between the glands and the aorta.

Figure 900 shows the exposure obtained with this oblique abdominal incision in a case in which the glands were extensively involved. The patient has had an excellent result.

By the technic above described, the lines of the lymphatics from the groin to the pedicle of the kidney are removed, with their various ramifications, in one

piece. Although the operation is very extensive, it is very satisfactorily radical, and simply requires patience and perseverance.

Closure.—If the peritoneum has been injured, it is closed with a catgut suture. In approximating the muscles we use a continuous, heavy, chromic catgut suture placed in two layers, one for the posterior and the other for the anterior portion of the abdominal muscles, including the fascia. The anterior layer of rectus abdominalis fascia which was divided transversely, is closed by a continuous layer of catgut sutures. The rectus muscle has not been disturbed. If the patient is quite fat, a running suture of catgut is inserted to approximate the subcutaneous tissues, and the skin is then closed as usual.

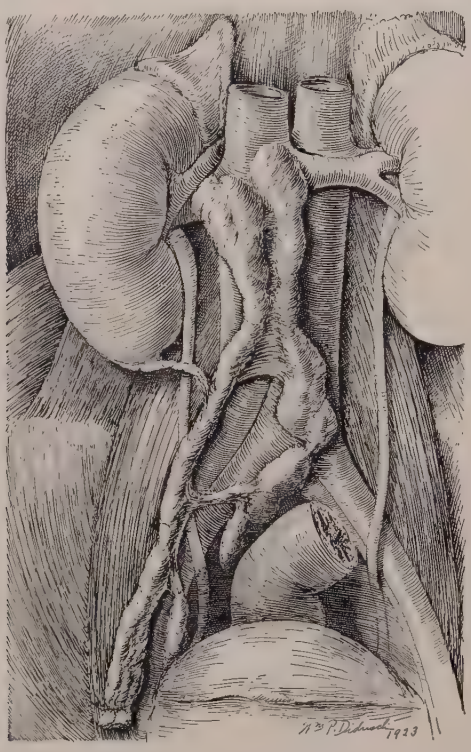


FIG. 901.—Metastases as found at operation (reconstruction). Note line of lymphatics from groin (ligated) into pelvis and up to kidney pedicles. B. U. I. 11,522.

In the operation above described, the inguinal canal is left intact, and requires no attention. The scrotal wound is closed first with deep sutures to obliterate the cavity in the scrotum, a superficial line of sutures is taken to draw the fascia together, and clips are applied. Where the single incision has been employed from the groin to the loin, if the inguinal canal has been opened, this will require very careful closure to prevent hernia.

Choice of Incision.—As shown in the accompanying drawing, the oblique incision from the groin to the loin divides the numerous nerves which supply the rectus and the other abdominal muscles in the epigastric region. The incision which we now employ is, therefore, much less destructive to the nerve supply, and preferable also on account of the greater facility with which the upper reaches of the operative field are explored. The latter part of the operation is the most diffi-

cult, and the two separate incisions which we have described above make this upper exposure easier. Bastienelli has told us of employing a somewhat similar transverse abdominal incision.

The radical operation for tumor of the testis is one of the most extensive in urologic surgery and frequently requires two or three hours in its performance. Although it leads one into very close proximity with both the aorta and vena cava, and it is frequently necessary to dissect glands which are quite closely adherent to them, the technic is not extremely difficult. The operation should unquestionably be carried out in all cases if possible.

Results.—The first study of the results obtained in our cases was made by Hinman[1] during his residency here. Hinman[2] has recently made a most thorough study of the literature, and we have collaborated in furnishing him the details of 7 cases in which radical operation has been carried out in this clinic. Hinman's statistics to October, 1923, are as follows:

"1. Seventy-nine cases of the radical operation for teratoma of the testis have been collected, either through personal collections or from the literature. Ten of these comprise personal cases, 5 of which have been previously reported. It is believed that sufficient information is furnished by this material to permit of reliable analysis for comparison with results following simple castration.

"2. Comparison of results of simple castration and radical operation shows, even at this early date, for the latter an improvement in the prognosis of at least 100 per cent., since about 15 per cent. of cases are cured by simple castration, whereas 30 per cent. of the 79 cases analyzed were found to have been cured by the radical operation."

Our own cases are analyzed in Chapter VIII.

FIG. 902.—Radical operation for malignant tumor of testis. Continuous incision from scrotum to back. Testicle and lymphatic line removed in one piece. Patient alive and well five and a half years later. B. U. I. 7666.

[1] Journal of the American Medical Association, 1914, lxiii, 2009–2014.

[2] Surgery, Gynecology, and Obstetrics, 1923, xxxvii, 429.

CASTRATION

In simple cases castration consists in simply making an incision in the upper portion of the scrotum, or lower portion of the groin, isolating the cord with its coverings, and clamping it high up near the external ring, withdrawal of the testicle and epididymis, surrounded by their coverings, from the scrotum, separation of the veins and vas above the point of clamping, and double ligature with heavy catgut; division with cautery, and removal of the testicular mass. Such is the operation carried out in tumor of the testicle where it is inadvisable to remove the glands of the retroperitoneal spaces, and also in tuberculosis when both epididymis and testicle are involved. When, however, there are abscesses or sinuses present, or even marked adhesion to the skin of the scrotum, the operative procedure has to be modified, so as to include excision of the affected area. In both tuberculosis and in tumors, it is very important to clamp or ligate the vessels of the cord before making great pressure upon the scrotal contents lest there be fluids or cells forced into the circulation from the affected region. As stated elsewhere, in tumor of the testicle, the radical operation should always be carried out unless serious contra-indications are present. In tuberculosis the epididymis is usually alone involved, and epididymectomy will generally suffice, even though a portion of the testicle may be involved. In such cases a V-shaped resection of the testicular lesion with the cautery and closure with catgut sutures is indicated. If impossible to remove all of the infected area cleanly, drainage may be desirable.

RESECTION OF TESTIS

This operation is indicated in certain forms of traumatism, benign tumors, cysts, certain inflammatory conditions, especially associated with pain, and occasionally when only a portion of the testicle is involved in tuberculosis along with the epididymis. The extent of the operation and the technic employed will vary according to the conditions present. In all cases it is necessary to open the tunica vaginalis. In tuberculosis, after removing the epididymis, the diseased portion of the testicle had best be excised, as a rule, with the electrocautery. By removing a wedge-shaped piece it is usually possible to close the resected area by mattress-sutures of catgut. Inflammatory nodules or cysts may be resected and the wounds closed. As a rule, it is well either to excise the tunica vaginalis or to turn it inside out and sew it behind the epididymis before closing the dartos and skin. Drainage may be advisable in cases of tuberculosis and sometimes for inflammatory conditions.

INCISION OF THE TESTIS FOR ABSCESS

Incision may be necessary in acute infections. These are generally associated with the epididymis. In most cases of acute infection of the epididymis and sometimes of the testicle, treatment by means of ice-packs is sufficient to eventually cause a disappearance of the inflammation so that operation is unnecessary. Corbus has recently proposed diathermy in epididymitis and reports good results. Belfield cautions against the use of great heat, as experiments have shown that atrophy of the testicle and sterility may result from such treatment. Where the infection has gone on to marked suppuration and especially if a localized area of fluctuation adherent to the skin is present, drainage is usually indicated. If the condition is extensive and particularly if two points of softening are made out, two incisions—one above and the other below—and through-and-through drain-

age with a well-ventilated rubber tube is usually the proper treatment. It is advisable not to make larger incisions for fear of getting hernia testis. We have seen cases in which the entire contents of the testicle were everted and poured out through an incised wound of the scrotum. Luys and others have advised injection of antiseptics directly into inflammations of the epididymis and testicle.

OPERATION FOR UNDESCENDED TESTICLE

The technic to be employed will depend upon the location of the testis, the condition of the spermatic vessels, vas, gubernaculum testis, etc.

Testis in Inguinal Canal.—In these cases when the canal is opened the appearance presented is that of an incomplete inguinal hernia. The testicle will be found surrounded by a sac of peritoneum from the lower end of which can be traced the gubernaculum testis which extends downward through the external ring and is attached to the scrotal tissues (Fig. 903, *a*). Not infrequently the vas deferens will be found accompanying the gubernaculum for a considerable distance, and great care must be taken not to injure it. When the peritoneum is opened the spermatic

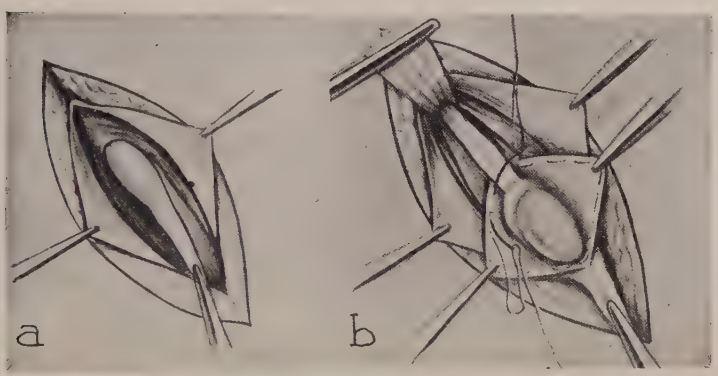


FIG. 903.—Operation for undescended testis: *a*, Inguinal canal opened, exposing testicle covered with peritoneum at upper end, gubernaculum running to spine of pubes; *b*, peritoneum opened. Peritoneal sac formed for testis, traction on gubernaculum to lower testicle. Bevan.

veins, in the form of a fairly prominent cord, will be seen beneath the posterior peritoneum. In the operation as carried out by Bevan, the next step is to excise the peritoneum immediately around the testis with sufficient redundancy to allow of the formation of a tunica vaginalis by means of a purse string suture (Fig. 903, *b*). Having freed the testis from its immediate attachments, traction is made, thus placing the spermatic vessels on tension, after which they are freed from immediate attachments posteriorly and to the peritoneum. In some cases it is possible to lengthen this spermatic bundle of vessels sufficiently to allow the testis to be drawn down into the scrotum. In most cases it will not be necessary to divide one or more of the spermatic vessels, but although every effort should be made to preserve at least one of the vessels, sometimes all have to be completely divided in order to transplant the testicle properly. The gubernaculum is divided as shown in Fig. 903, *a*. A pouch for the testis is made in the scrotum by simply inserting the finger and enlarging the wound. Bevan and others have employed a suture which is attached to the testicular coverings at the upper end and brought out through the lower end of the scrotum in order to draw the testicle down to the

bottom of the pouch which has been made for it, but we have not found this necessary. Having placed the testis in the bottom of the scrotum, it is held there by forming a firm musculofibrous constricting mass of tissues which are brought together by means of chromic catgut sutures immediately above the testis in the scrotum. A bottle-neck is thus formed which holds the testis in the scrotal pouch. The various complicated operations which have been devised to hold the testis down are not necessary.

Closure is effected as for inguinal hernia (Fig. 904).

The Testis Above the Canal Behind the Peritoneum.—In such cases much greater difficulty is experienced in properly planting the testis in the scrotum. The spermatic vessels are shorter and offer more resistance to transplantation and the vas deferens may also be quite short. In these cases it is generally necessary to divide the deep epigastric vessels in order to bring the vas and cord sufficiently low to allow transplantation, and in many cases it is necessary to divide the spermatic vessels completely. If such is the case, as much tissue as possible should be left to

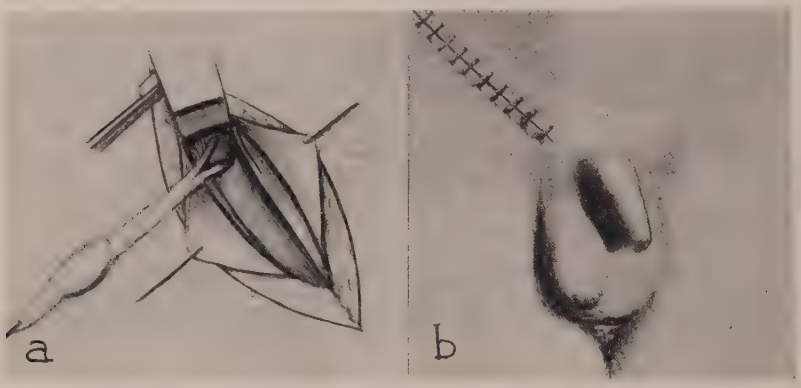


Fig. 904.—*a*, Internal ring stretched and peritoneum freed from posterior abdominal wall exposing spermatic vessels and vas as they separate; vessels divided if necessary; *b*, the testicle is placed in pouch made by blunt dissection of scrotal sac and held there by sutures forming constriction above testis. Inguinal canal closed as for hernia, skin closed. Bevan.

accompany the vas and thus supply sufficient vascularity to prevent atrophy of the testis.

Testis in Abdominal Cavity.—In these cases a pedicle of peritoneum, vessels, vas, and gubernaculum is found which runs from the region of the internal ring to the testis. After delivering the testis externally the greatest care should be taken in opening up this peritoneal pedicle and in exposing and separating the constituent structures. The vessels will often be found sufficiently long to allow transplantation without much difficulty, and the vas, which is usually closely adherent to the gubernaculum and must be preserved with great care, often offers no restriction to transplantation. It may be impossible to form a new tunic for the testis of peritoneum, but this is of no moment, as a matter of fact, in most cases operated here no effort has been made to form a new tunica vaginalis.

Clinical study of cases and results of operations for undescended testis:

The following tables represent the data obtained from a study by E. C. James of 125 cases of undescended testicle, admitted to the Johns Hopkins Hospital, of which 57 were admitted to the Brady Urological Institute:

TABLE 178

CASES OF UNDESCENDED TESTICLE

Total cases, J. H. H.	125
Percentage of total admissions, J. H. H.	0.069
Total cases, General Surgery	68
Percentage of total admissions, General Surgery	0.10
Total cases, B. U. I.	57
Percentage of total admissions, B. U. I.	0.42

TABLE 179

UNDESCENDED TESTIS

Age.	Cases.	Percentage.
Under 5	0	0
5–10	12	9.6
10–15	21	16.8
15–20	24	19.2
20–30	24	19.2
30–40	21	16.8
40–50	6	4.8
50–60	7	5.6
60–70	3	2.4
70–80	2	1.6
Undetermined	5	4.0
Civil state.		
Single	82	65.6
Married	37	29.6
Undetermined	6	4.8
Occupation.		
Sedentary	23	18.4
Active	47	37.6
School	30	24.0
Undetermined	25	20.0
Chief complaint.		
Undescended testis	12	9.6
Hernia	37	29.6
Pain	36	28.8
Mass	6	4.8
Tumor	1	0.8
Phimosis	1	0.8
Dysuria	1	0.8
Genital defects	1	0.8
Small testis	1	0.8
Not reported	29	23.2
Family history.		
Undescended testis in brother	1	0.8
Undescended testis in father	1	0.8
Total	2	1.6

Special Case: Tenth child. Mother forty-one at his birth. Both testes undescended. Underdevelopment generally. Pseudohermaphroditism. No testes found.

TABLE 179 (Continued)

UNDESCENDED TESTIS

Sexual powers lacking in	Cases.	Percentage.
Libido	6	4.8
Potentia	7	5.6
Erections	2	1.6
Ejaculations	7	5.6
Sterile	5	4.0
Athletic inclination	61	48.8
Apathetic: Slightly	6	
Moderately	10	
Very	1	
Total	17	13.6
Not stated	47	37.6
Size.		
Very fat	1	0.8
Fat	7	5.6
Medium	90	72.0
Thin	18	14.4
Very thin	2	1.6
Not stated	7	5.6

Feminism:

Marked degree (4 cases, 3.2 per cent.)

1. Undescended testis, left, abdominal, Fröhlich's syndrome.
2. No testes found. Marked mons.
3. Testes very small, upper scrotum.
4. Very atrophic testes. Marked infantilism. General genital aplasia.

Moderate degree (3 cases, 2.4 per cent.)

1. Right and left inguinal. Very seclusive and underdeveloped.
2. Left inguinal and right inguinal (?). Marked underdevelopment.
3. Right and left abdominal. Fröhlich's syndrome.

Slight degree (5 cases, 4 per cent.)

1. Right and left inguinal (?). Underdeveloped.
2. Right subinguinal and left abdominal. Underdeveloped.
3. Right and left abdominal. Infantilism.
4. Right inguinal. Slight feminism.
5. Right and left inguinal. Underdeveloped.

Total cases showing feminism: 12, or 9.6 per cent.

	Cases.	Percentage.
Feminine: Skeleton	7	5.6
Musculature	7	5.6
Voice	7	5.6
Breasts	6	4.8
Hair distribution	8	6.4

TABLE 180

UNDESCENDED TESTIS

Location.		Cases.	Percentage.
Inguinal, right		43	34.4
left		14	11.2
bilateral		10	8.0
Subinguinal, right		10	8.0
left		10	8.0
bilateral		0	0
Abdominal, right		8	6.4
left		17	13.6
bilateral		6	4.8
Included under two headings	One inguinal and one abdominal	7	5.6
	One inguinal and one subinguinal	4	3.2
	One abdominal and one subinguinal	9	7.2
Ectopic, groin		1	0.8
pubic		1	0.8
perineal		1	0.8
Total		3	
Absent		2	1.6
Small, atrophic scrotal		2	1.6
Total		145	

TABLE 181

UNDESCENDED TESTIS

Cases showing definite atrophy of testis:		Cases.	Percentage.
Right	Extreme	5	4.0
	Moderate	9	7.2
	Slight, but definite	40	32.0
Total right		54	43.2
Left	Extreme	3	2.4
	Moderate	8	6.4
	Slight, but definite	26	20.8
Total left		37	29.6
Bilateral (as detailed below)		17	13.6
Total cases of atrophy		74	59.2
Cases of bilateral atrophy showed:			
Pseudohermaphroditism		2	1.6
Fröhlich's syndrome		2	1.6
Infantilism		2	1.6
Marked feminism		2	1.6
No general disturbance (atrophy of one testis very slight)		2	1.6
No general disturbance (atrophy of both very slight)		3	2.4
Moderate atrophy of both, slight feminism		1	0.8
Moderate atrophy of both, no feminism		2	1.6
Atrophy due to orchitis, no feminism		1	0.8
Total		17	13.6

TABLE 181 (Continued)

ASSOCIATED GENITAL STRUCTURES

Testes palpable:

One —77 cases—61.6 per cent.
Both—10 cases— 8.0 per cent.

Scrotum:

Invariably shrunken on affected side.
Bifid in 1 case—0.8 per cent.

Prostate:	Cases.	Percentage.
Marked underdevelopment	2	1.6
Slight underdevelopment	6	4.8

Seminal vesicles:		
Marked underdevelopment	1	0.8
Slight underdevelopment	6	4.8
Absent (infantilism case)	1	0.8

Associated hypospadias:

Cases—4 Percentage 3.2
(One was a case of pseudohermaphroditism.)

Associated epispadias:

Cases—0 Percentage 0

Associated varicocele:		
Right	0	0
Left	4	3.2
Side opposite from undescended testis	4	3.2

Associated hydrocele:		
Right	5	4.0
Left	4	3.2
Side opposite from undescended testis	3	2.4
Side the same as undescended testis	4	3.2
Side not given	2	1.6

Associated congenital chordee:

Cases—3 Percentage 2.4

Epididymis:		
Marked underdevelopment	2	1.6
Moderate underdevelopment	10	8.0
Slight or no underdevelopment	95	76.0
Left very long	1	0.8
Absent (Fröhlich's case)	1	0.8

Vas:		
Very short	1	0.8
Short	8	6.4
Long	2	1.6
Very long	1	0.8
Very short, bilateral	1	0.8
Absent, right	2	1.6
Absent, left	0	0.0

TABLE 181 (Continued)

ASSOCIATED GENITAL STRUCTURES

Penis:	Cases.	Percentage.
Very underdeveloped	1	0.8
Moderately underdeveloped	5	4.0
Associated inguinal hernia:		
Right, uncomplicated	48	38.4
sliding	1	0.8
strangulated	1	0.8
Total	50	40.0
Left, uncomplicated	23	18.4
sliding	0	0
strangulated	0	0
Total	23	18.4
Bilateral cases	9	7.2
Total cases	64	51.2
Total herniæ	73	

TABLE 182

UNDESCENDED TESTIS

Malignant tumor in undescended testes:	Cases.	Percentage.
Right inguinal	2	1.6
abdominal	2	1.6
Left abdominal	1	0.8
Total	5	4.0

Injuries to undescended testis:

Crushing injuries:	1	4 years ago
	2	17 "
	3	6 "
	4	10 "
	5	4 "
	6	17 "
	7	10 "
	8	not given
	9	"
	Total	9 cases—7.2 per cent.

Previous operations:	Cases.	Percentage.
For undescended testis, once	4	3.2
testis, twice	1	0.8
For hernia, once	1	0.8
twice	1	0.8

TABLE 183

Operations for undescended testis at J. H. H.: *Bevan or slightly modified Bevan:*	In General Surgery: Cases.	In General Surgery: Per cent. of all cases.	In B. U. I.: Cases.	In B. U. I.: Per cent. of all cases.
No vessels cut	22	17.6	15	12.0
Part vessels cut	1	0.8	6	4.8
All vessels cut	1	0.8	3	2.4
With testis sutured to scrotum	4	3.2	2	1.6
With tunic, vessels cut	5	4.0	1	0.8
With tunic, part of vessels cut	0	0.0	1	0.8
Suture of scrotum to thigh	0	0.0	1	0.8
Castration (tumor present)	3	0.0	0	0.0
Castration (no tumor, but atrophy)	11	8.8	1	0.8
Operation for other causes in cases which also had undescended testis	9	7.2	3	2.4
Unusual operation, in which small testis was sutured in upper part of scrotum	1	0.8	0	0.0
Implantation of testes	0	0.0	1	0.8
Total operations on cases of undescended testis	57	45.6	34	27.2
Total operations on cases of undescended testis for this condition specifically	48	38.4	31	24.8
Total, all cases			79	

In regard to results, we have, unfortunately, been able to obtain late reports in only 77 per cent. of our own cases. In only 2 do we know that the result has been satisfactory for more than ten years. In 6 there has been no recurrence from five to ten years after the operation and in 7 for less than five years. The details of these 8 successful cases are given in Table 184.

In 9 cases it was noted that there was some upward movement of the testis before discharge from the hospital. In all these cases the Bevan operation had been performed. It is noteworthy that in 7 of them no vessels were cut. In only 1 case, however, did the testis go further than the upper part of the scrotum and in this 1 case its position is described as "at the edge of the abdominal wound."

Every effort to reach the remaining 7 cases, where the condition was unsatisfactory on discharge but who had not been heard from, proved unsuccessful.

TABLE 184

Followed ten years or more:

1. B. U. I. 2575—Modified Bevan, bilateral, vessels cut. Health good. Testis in upper part of scrotum, no children. Fifteen years.
2. B. U. I. 3845—Modified Bevan, right, vessels cut. Health good, no children. Twelve years.

Followed five to ten years:

1. B. U. I. 4192—Modified Bevan, left, vessels cut. Good health, married sixteen years, no children, no atrophy of testis. Nine years.
2. B. U. I. 5958—Modified Bevan, left, vessels cut. Health good, has had children since operation. Testis in upper part of scrotum. Eight years.
3. B. U. I. 6940—Modified Bevan, left, no vessels cut. Health good, testis in upper part of scrotum and has grown larger, patient single. Seven years.
4. B. U. I. 6565—Modified Bevan, right, no vessels cut. Health good, testis in upper part of scrotum, no children. Seven years.
5. B. U. I. 7249—Modified Bevan, bilateral, vessels cut. Health good, testis in scrotum, no children, patient single. Seven years.
6. B. U. I. 1183—Scrotum to thigh operation. Health good. Secondary sexual characteristics improved. One testis increased, the other decreased in size. No report as to children. Six years.

Conclusions as to Operations for Undescended Testis.—Where double, the operation should be carried out well before puberty. If one normal testis is in the scrotum and the other intra-abdominal, no hernia being present, no operation is indicated, generally. Where the testis is in the groin and especially if associated with hernia, operation should be done even if so late as to be improbable that growth of the testis would result. Operation before the age of seven is contraindicated.

Bevan's operation is scientifically designed and generally successful.

OPERATIONS ON THE SCROTUM

Ablation of Scrotum.—This operation is generally carried out on account of great redundancy of the scrotum, generally associated with varicocele. The patient often insists upon the operation owing to the unsightliness and occasional discomfort produced by the condition. The operation simply consists in clamping the lower portion of the scrotum and dividing the skin and subcutaneous tissue. Numerous vessels are encountered and should be carefully clamped and ligated, and the wound closed in two layers. Throughout the operation care should be taken not to injure the testicle, epididymis, vas or veins.

Fig. 905.—Operation to remove large cyst of urethra. B. U. I. 10,930.

The operation is rarely indicated, even in cases where the scrotum is considerably more redundant than normal. Excision of the varicose veins of the cord, with the suspension obtained by joining the upper and lower stumps of the veins together, will usually be sufficient to relieve the downward pressure of the scrotal contents, and the skin generally promptly atrophies, shortens, and redundancy disappears to a considerable extent. In some cases, however, it may be quite justifiable.

Cysts of the scrotum are simply dissected out, and if very large, it may be advisable to resect a portion of the scrotal skin (Figs. 905, 906).

Resection of Scrotum.—When done for *malignant tumor* (epithelioma), this should be as thorough and as complete as required, and include a wide area of dissection. If the scrotal contents on the side involved are adherent, castration should usually be carried out. It is important to remove the glands of the groin and, as a rule, it is wise to begin the operation with an incision in the groin followed by complete dissection of the glands of the groin from above downward, including those in the adjacent femoral space.

The scrotum does not drain into the lymphatics of the cord, and, therefore, it is not necessary to open the inguinal canal. If the testicle is involved, it is quite

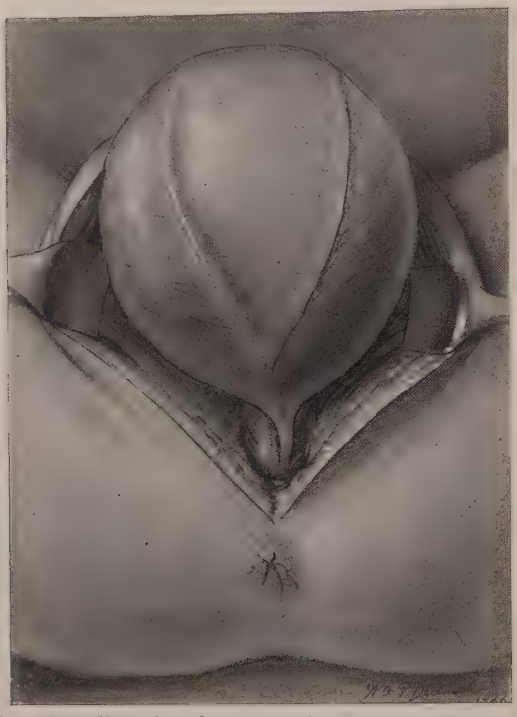


FIG. 906.—Huge cyst of urethra; dissection almost complete, showing connection with bulbous urethra. B. U. I. 10,930.

possible that the radical operation previously described for tumor of the testicle should be carried out, but no case on record in which this has been done has come to our notice.

An illustrative case of epithelioma of the scrotum follows:

B. U. I. 10,842, aged fifty-nine, occupation fireman. History is negative until fifteen months before admission when patient noticed small pimple on left side of scrotum about the size of a pinhead. This increased gradually and became ulcerated about eight months before admission. There had been no treatment except local applications and ulcer had grown until at time of admission it was about 7 x 4 cm. in size. It was confined entirely to the left half of the scrotum. The ulcer was erosive in character with no proliferative masses and edges were moderately indurated. The inguinal glands on both sides were enlarged and indurated, more so on the left. Examination was otherwise negative. Operation; resection of ulcer with wide skin margin; left orchidectomy; removal of left inguinal glands. Convalescence was interrupted by a slight ne-

crosis of skin edges, but patient was well on discharge. He received ten deep *x*-ray treatments. The specimen removed showed squamous-celled epithelioma. Testis was not involved but there were metastases in the inguinal lymph-nodes. No report since discharge.

The only other case of epithelioma of the scrotum we have seen failed to return for operation.

Operation for the Non-tropical Form of Elephantiasis of Scrotum.—Not infrequently postoperative and other forms of non-tropical elephantiasis may require operation on account of the deformity and interference with normal urinary and sexual functions. Occasionally, swelling, edema, and fibrous induration are so great as to produce a huge mass and great relief can be afforded by operative excision with appropriate plastics to cover the defect with fairly normal skin.

We have recently had a case in which the entire scrotum presented an extensive enlargement associated with marked edema and chronic fibrous thickening of the subcutaneous structures involving almost all the scrotal skin. The skin of the penis was also involved in this extensive process, the great edema and brawny induration of the foreskin being so extensive as to interfere with coitus. In this case there was, fortunately, an area of fairly healthy skin on one side of the scrotum, and we were able, after excising the entire region of skin and subcutaneous tissue involved, to cover the penis, which had been almost completely denuded, with a layer of skin taken from the side of the scrotum. An abstract of this case follows:

B. U. I. 10,561, age twenty-nine, married. Admitted June 10, 1922. Complaint: "Enlarged privates." Family history negative. In 1913 operation for hernia, right side, also appendectomy; 1914, herniotomy, left side. Recurred, operation repeated in 1915. Fourth operation for double hernia in 1916. Circumcision in 1921. This and other operations were followed by considerable hemorrhage. Patient has never resided in the tropics. Born in Greece, has lived in America fifteen years; in Washington, D. C., 1907 to 1911; Alabama, 1916; New England, 1917 to 1920; Florida last two years. General health fair. Patient had gonorrhea in 1913 and about same time an ulcer on the penis. No secondary eruption, but was given two doses of salvarsan. Present illness began about two and a half years ago with slight thickening of the penis and scrotum without pain. Since then there has been a slight growth. In 1921 prepuce had become very large and circumcision was performed; followed by considerable hemorrhage. Later in 1921 had fever for several weeks with chills. During attacks of fever, swelling in scrotum almost completely disappeared (he thinks). Two weeks ago had attack of fever with temperature of 103° F., felt sleepy and had chills and sweats. This sweating is unilateral on left side of body and face and left side of scrotum gets red and hot. During the fever, swelling of scrotum disappears but returns again in twenty-four hours. States that penis and scrotum have at times been so greatly enlarged as to weigh 10 pounds. No frequency of urination, no pain, no hematuria, no hesitancy of urination.

Examination, June 10, 1922: Penis is 5 cm. in diameter and 9 cm. long in flaccid state. Skin is very edematous, the meatus is turned in and the glans cannot be seen. Lower lip of the foreskin at least 3 cm. in thickness. The skin over the shaft of the penis is thick and pits slightly on deep pressure. When the foreskin is withdrawn glans appears normal in size and shape, the skin covering the glans and the corona is normal in appearance, no edema, no thickening. Scrotum very much enlarged, being about 13 cm. wide, 12 to 13 cm. thick, and 15 cm. long. It is covered with skin which is purplish in color and at one point shows a slight abrasion. The skin and subcutaneous tissue of the scrotum are greatly thickened, firm, do not pit markedly on pressure. Left testicle is of normal size and epididymis can be palpated, does not seem to be enlarged. Cord is negative. In the right side of the scrotum there is a thickened mass in the upper part, but no testicle can be distinctly made out. There is a hernial scar in the left inguinal region and inguinal glands are palpable. External ring small and no impulse on coughing. Right inguinal region shows large irregular scar 13 x 5 cm. in size and on palpation tissues are hard and cicatricial. Inguinal glands are palpable.

Impression.—Cured inguinal hernia, left. Recurrent inguinal hernia, right. Marked scar tissue in groins. Elephantiasis of penis and scrotum, lymphatic stasis.

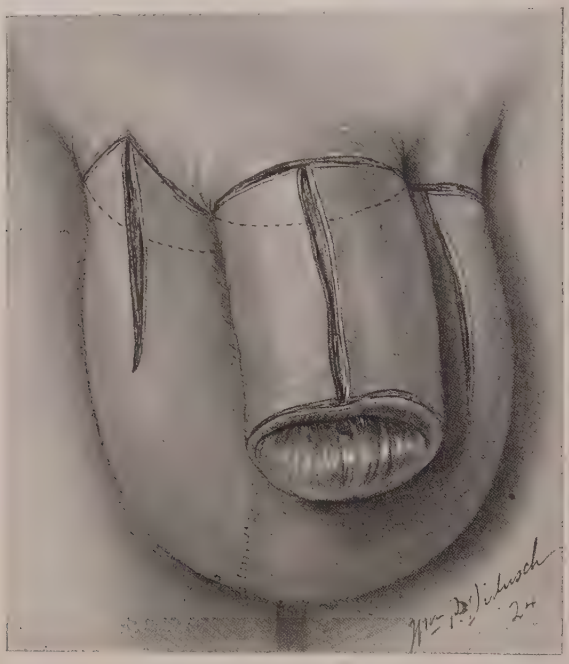


Fig. 907.—Elephantiasis of scrotum and penis. Huge enlargement. Thick brawny induration of skin and subcutaneous tissues. Showing incisions made for excision of skin and affected subcutaneous tissues. Inner layer of foreskin is preserved, not being involved. B. U. I. 10,561.

Fig. 908.—Elephantiasis of scrotum and penis. Condition left after excision of scrotum and right testis and skin of penis. The inner surface of redundant foreskin was not involved in sclerotic process and was preserved as a covering for penis. B. U. I. 10,561.

The patient states that he is able to have intercourse. This seems very remarkable, but his wife is a huge woman and frankly admits it is rather large and the operation is performed with some difficulty. They both desire operative relief for the huge enlargement.

June 23, 1922: Operation, Young; gas and ether. Excision of elephantiasis of scrotum and penis. Castration, right side. Plastic to supply new skin for penis and scrotum. Closure with interrupted sutures of fine silk. Careful hemostasis, good plastic result obtained. The main flap from scrotum on left side was wound around the penis, almost completely covering it. Additional flap taken from right side of piece of scrotum to complete the covering. On examination before operation it was found that there was a small area of skin in the upper portion of the scrotum which was normal. Below this point the skin was thick and on pressure was fibrous and hard. The line of excision extended across in front of scrotum on left side around the posterior aspect until the right groin was reached (Fig. 907). Thus a huge amount of skin, subcutaneous tissue, right testicle and cord, which were involved, were removed (Fig. 908). Left testicle and cord were surrounded by marked edema, but were not involved and were left behind. It was found that the mucous membrane beneath the foreskin was not edematous and presented a healthy surface for distance of about 2½ cm. back of the corona. This was utilized to cover almost half of shaft of penis, which was completely denuded. The skin that remained at base of penis on left side, an area about 2½ cm. square, was utilized on dorsum and skin brought around to meet this on left side. A long flap from left side also drawn around, forming circular

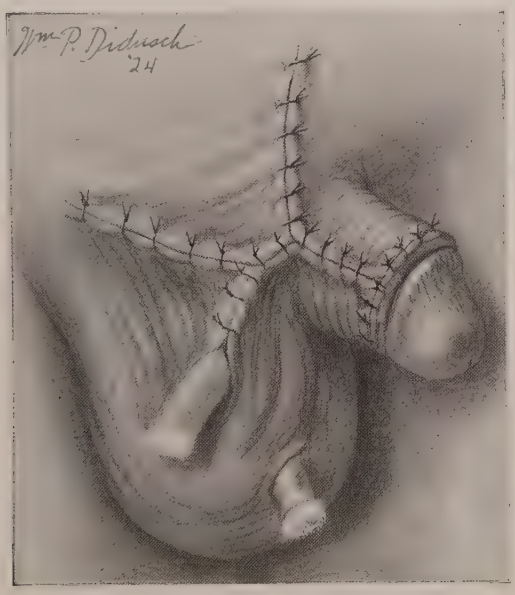


Fig. 909.—Elephantiasis of scrotum and penis. Plastic to close defect after removal of almost all of skin of penis and scrotum. B. U. I. 10,561.

covering or cuff. The penis was covered with fresh, normal, soft skin without tension and there is every prospect of getting a radical cure and a good result. The shaft of the penis was not in any way involved (beneath the skin). Before closing, several incisions were made through fascia covering shaft of penis to allow for collateral circulation and drainage of deeper lymphatics of shaft of the penis (Fig. 909). Pathologic report: The specimen consists of an enormous sac measuring 15 x 10 x 7 cm. It is greatly thickened and very edematous. The testicle measures 6 x 4 x 2 cm., surrounded by rough tissue, markedly edematous. On section showed scar tissue. In one place a small mass of tubules, resembling epididymis, seen. Microscopic examination: The testis was atrophic. The remaining tissue showed merely fibrosis and edema.

July 8, 1922. Discharge note: Patient has had a very remarkable result. There has been no breakdown of the wound and it is solidly healed. Skin around penis, which came from the left side of the scrotum, has healed perfectly; there is no edema. The penis is completely covered with skin. That portion of the shaft covered by retracted foreskin is well healed, slightly edematous. A small amount of skin, about 2½ cm. in diameter, is all that remains of the skin which originally covered penis along dorsum and now lies at upper end. This is also free from edema. There is no evidence of elephantiasis or any other condition.

The scrotum is completely covered with healthy skin. The left testicle can be palpated beneath skin and near root of penis, where it causes no inconvenience and is apparently normal. Result obtained is excellent. Report by letter August 20, 1922: Patient is in excellent condition, intercourse is fairly normal and satisfactory. Report by letter December 21, 1922: There has been no return of the swelling. Penis is fairly normal. Sexual intercourse indulged in, not quite normal. Wife writes that the penis seems very small.

CHAPTER XX

OPERATIONS UPON THE URETHRA

INSTRUMENTATION

Bougies are of two types—bougies à boule and filiforms. The bougie à boule, as shown in Fig. 623, is an instrument with a bulb at each end, one of which is olivary in type and the other shaped like an acorn. This bougie is usually made of linen covered with gum, though metal bougies are also used. The object of this instrument is to detect irregularities and strictures in the urethra. A complete set varies in size from No. 6 up to No. 30 F.

In the employment of a bougie the penis should be drawn out so that the external urethra forms practically a straight course. The bougie is held delicately

Fig. 910.—Showing tendency of sound to catch in dilated bulbous urethra in front of external sphincter. This may be prevented by pressure of finger against perineum, obliterating pouch and guiding sound into membranous urethra.

between the thumb and finger and careful exploration is made to detect irregularities, roughness, and strictures, etc. It is well to start with a fairly large bougie, say No. 24 or larger, and if obstructions are made out, to use progressively smaller sizes until one will pass. The instrument is then slowly withdrawn, and by noting where the stricture is encountered and when the bulb passes through it, a fairly accurate idea of the length of the stricture can be obtained. Bougies meet with temporary obstruction at the external sphincter, which is sometimes held so firmly closed that they will not pass through the membranous urethra. At other times, having passed through the prostate, they may meet obstruction at the verumontanum or at the median portion of the prostate. They may be arrested by pouches or false passages anywhere along the tract.

Sounds.—These are instruments of metal curved to follow the normal urethral arc. We have heretofore described the many varieties which have been devised and their difference in curve, caliber, and contour (Fig. 624). For general usage in adult individuals sounds vary from No. 16 to No. 30 F. in size. It is well to have a set which includes every other number between 16 and 30. The even numbers

are probably preferable, and only for very large clinics may it be desirable to have every number. A sound is preferably made of non-rusting steel or brass nickel plated. Sounds made of steel have the disadvantage of rusting and causing traumatism when used.

In examining the urethra with sounds it is well to start with a fairly large instrument, say No. 24. With the patient lying upon his back, legs extended and slightly separated, the genitalia having been carefully cleaned up with soap and water, alcohol, or other antiseptic, the urethra injected with some mild antiseptic (meroxyl, 1 : 500) and anesthetized by injection of novocain, the operator takes a position to the left side of the patient's hip, grasps the handle of the sound in his right hand and the penis in the left. The sound is grasped at its outer end, and held very delicately between the thumb and finger. The penis is suspended between the thumb and finger of the left hand and the organ is drawn toward the groin while the instrument well lubricated is introduced into the meatus and gradually carried downward until the tip passes the region of the suspensory ligament and reaches the anterior part of the bulbus urethra. The instrument is then carried to the median line and pushed further along the urethra until it approaches the membranous urethra and external sphincter. Just in front of this lies the bulbous urethra which is apt to be large or even sacculated. It is well at this point of the procedure to release the hold on the penis and place the pulp of the middle finger of the left hand upon the perineum so as to make pressure and obliterate the arch of the bulb (Fig. 910), and act as a guide or fulcrum to carry the beak of the sound through the membranous urethra. The presence of the finger in the perineum also adds considerably to the *tactus eruditus* and gives the operator a better knowledge of just where the beak of the instrument is and how much resistence is being encountered. It is also of distinct assistance in carrying the beak of the instrument through the membranous into the prostatic urethra. When this point is reached the left hand is removed from the perineum and grasps the handle of the instrument, replacing the right hand. The fingers of the right hand are then used to depress the suspensory ligament and straighten out the curve of the urethra so as to facilitate the further passage of the sound through the urethra into the bladder. This is accomplished by simply pressing with the middle finger upon the root of the penis in front of the symphysis. Deep pressure here stretches the triangular ligament and greatly reduces the curve of the urethra. Usually no difficulty is encountered in a normal case in passing a sound of moderate size (up to No. 26 French) through the urethra until the straight portion of the instrument passes through into the bladder (which should always contain fluid so that the beak of the instrument has room for certain movements in the bladder cavity). If the patient has just voided, one should fill the bladder with some antiseptic solution before instrumentation, but in stricture cases, where this may be impossible, it is well to see that the patient does not void more than a portion of the urine before instrumentation is attempted.

INTERNAL URETHROTOMY

This operation may be used in cases which cannot be satisfactorily treated by dilatation of the urethra or where quick results must be obtained. It is only applicable in cases where an instrument can be passed through the point of stricture.

In our experience the urethrotome of Maisonneuve is the best. Before the

operation it is essential to know that the bladder contains a good amount of fluid. If the patient has just voided urine and it is impossible to fill the bladder with a syringe, the patient should be instructed to drink water and retain urine until the bladder becomes more or less filled so that the filiform and metal instruments will have space for manipulation within the bladder.

The filiform is passed well into the bladder and the staff screwed tightly into it. Drawing the penis out, until it is under considerable tension, the staff is then passed slowly through the stricture until the inner end has reached well within the prostatic urethra. The staff which is then in a more or less vertical position is intrusted to an assistant while the operator passes into it the wire obturator carrying a guarded knife (Fig. 911).

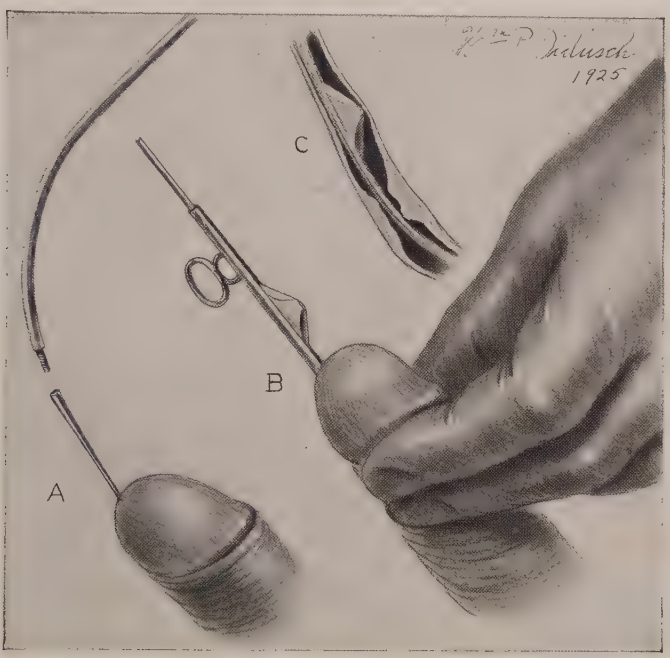


FIG. 911.—Internal urethrotomy with Maisonneuve urethrotome: *A*, Filiform introduced through stricture is screwed on to guide; *B*, introduction of cutting blade, tip provided with guard to protect unstrictured urethra; *C*, longitudinal section showing knife approaching stricture.

Drawing the penis outward in extreme tension the operator slowly slides the knife down the grooved staff, passing into the meatus and down the urethra until the point of stricture is reached. The guard upon the knife prevents cutting the normal urethra. When the point of stricture is reached resistance will be felt, and the operator, increasing his pressure, slowly forces the knife blade through the stricture, being careful not to go too far. When release of obstruction indicates that the stricture has been passed one goes still further to search out additional strictures which are, in turn, similarly divided. There is, however, this precaution to be taken: unless absolutely necessary the knife blade should not be carried beyond the posterior part of the bulb; *i. e.*, into the membranous urethra containing the external sphincter, which should not be divided in internal urethrotomy as considerable hemorrhage may be encountered in this region. Having divided the stricture and withdrawing the knife-bearing obturator, the operator, if he wishes,

may introduce a larger blade and, following the original track, make the incisions deeper. Unless the stricture is very dense it is usually more satisfactory to pass a large blade at the beginning and do the operation at one cutting. The cut should always be made upon the roof of the urethra, and additional cuts are not necessary or desirable. The tunneled staff may then be withdrawn, but the filiform should be left in place and as soon as the staff has been removed by unscrewing it from the filiform, a sound or dilator should be screwed upon the filiform and slowly passed through the divided strictures into the bladder. Successive sounds up to No. 28 F., or even 30 F., if passed without too much force, should be used to dilate the strictured areas widely. The filiform may then be withdrawn from the urethra, and if the hemorrhage is not pronounced, nothing further need be done at this séance. If there is abundant hemorrhage, it is often advisable to pass a large rubber catheter, say 24 or 26 F., into the bladder, which should be washed out with a warm antiseptic solution. The catheter is fastened in place by adhesive plaster, the end corked, and the patient returned to the ward.

Subsequent Treatment.—The bladder should be irrigated occasionally with antiseptic solution to avoid infection and the patient given water in large amounts by mouth. If the bladder has been chronically dilated as a result of the stricture, there may be danger of suppression of urine. Sounds should be passed at sufficiently frequent intervals to keep the stricture from recurring and to lead to absorption of the cicatricial tissue, at first every four days, later about once a week, the largest being allowed to remain in place for several minutes. The urethra may be massaged at the point of the strictures to hasten absorption of the cicatrix.

Complications.—Hemorrhage is the most serious complication of internal urethrotomy and has, in a few cases, resulted in fatality. Such instances have almost always been where the stricture was localized in the deep urethra (membranous region), and autopsy has shown that in withdrawing the knife around the curve of the urethra in this region, the blade has penetrated very deeply, severing important blood-vessels. On this account the operation of internal urethrotomy should be reserved for strictures of the pendulous and the anterior part of the bulbous urethra. For the membranous region internal urethrotomy is to be avoided if possible and the attempt to cure with filiforms and followers should be persisted in. If operation is necessary, external urethrotomy through the perineum should usually be carried out. Occasionally fairly profuse hemorrhage does occur in urethrotomy of the pendulous or bulbous urethra. The use of a very large retained catheter will generally be sufficient. If the bleeding comes from the pendulous urethra, the use of adhesive around the penis to compress the tissues tightly around the retained catheter may be of assistance.

Where the hemorrhage persists sufficiently to become alarming (in deep perineal urethrotomy) an incision should be made in the perineum so as to expose the site of bleeding which may be arrested with a clamp or transfixion ligature of catgut. If these methods are unsuccessful, drainage of the bladder with a large tube, and deep packing of the wound will usually suffice. In case of exsanguination or bleeding from a hemophilic condition transfusion of another's blood may be required.

EXTERNAL URETHROTOMY

By this is meant opening the urethra in the perineum. One never makes an incision into the urethra in the pendulous portion, as the covering tissues are so

thin that a fistula is very apt to follow. External urethrotomy is frequently carried out simply for drainage of the bladder in order that the penile urethra may be kept free from urine during the convalescence from the plastic operation for hypospadias, etc. The point of election for external urethrotomy is in the anterior part of the bulbous urethra. The incision is in the median line and is made as short as possible, consistent with successful dealing with the mucous membrane of the urethra. Before making the incision one may insert either a grooved staff (preferably) or a sound, and while an assistant holds the curve of this forcibly against the perineum, the operator makes pressure upon the skin on each side of the instrument so as to render the tissues tense and thin. In thin individuals an incision of 2 cm. is made and passes quickly through the skin, subcutaneous fascia, perineal fascia (Colles), cavernous tissue, and mucous membrane into the urethra. With clips, forceps, or sutures the mucous membrane is then caught up and retracted so that the operator may insert catheters, sounds, or carry out other instrumentation as soon as the instrument within the penis has been withdrawn. Where drainage is to be carried out one uses a fairly large catheter, 24 or 26 F., so as to obturate well the deep urethra. This catheter is introduced a sufficient distance into the bladder to secure good drainage and then fastened in that position by means of a fixation stitch through the skin, preferably on each side. As urine is

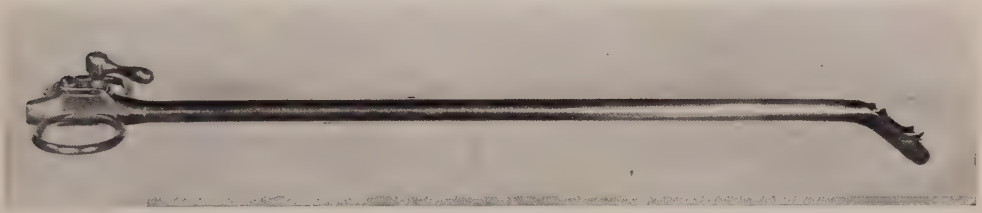


FIG. 912.—Young's urethrotomy guide provided with spiked elevator for holding edges of mucous membrane after incision and thus facilitating picking up edges with Allis clamps.

sometimes forced through the perineal wound around the catheter (from accidental stoppage of the drainage or violent contracture of the bladder), it may in the same way be forced into the urethra anterior to the urethrotomy wound. Such a mishap may cause infected urine to reach the anterior urethra which has been the site of a plastic operation. It must be avoided if possible. This may be accomplished either by placing a light pack in the urethra in front of the perineal catheter drain or by passing an encircling stitch of silk around the urethra, externally to the perineal catheter. We have employed the latter method quite frequently, but find that care must be taken not to tie the ligature too tightly, or it may cut through. After making the incision into the urethra one often encounters difficulty in seizing the mucous membrane, which is apt to retract as soon as divided. To avoid this mishap and to facilitate this operation we have devised a special urethrotomy instrument (Fig. 912) which is provided with an obturator armed with small spikes which may be projected outward at the point to be incised so as to hold up the mucous membrane and prevent its retracting when cut. The instrument is introduced closed. The curve of the beak is then pressed against the perineum at the point where it is to be incised, and the spiked obturator is brought into play by turning the operating mechanism in the handle (Figs. 914, 915). A very small incision is then made through the tense skin and when the urethra is opened the

edges of the mucous membrane are found elevated upon the small spikes, and may then be easily caught up with clips, which should be so constructed as not to crush the urethra (Allis clamps). This simple instrument has greatly facilitated urethrotomy both for simple drainage and for stricture.

We do not employ and do not recommend the old operation of cutting upon the "gripe" or stabbing through the perineum with a sharp bistoury into a grooved sound, either for drainage or the division of a stricture. The great objection to this blind operation is that one does not see the mucous membrane which has been divided. It is therefore difficult to pick up the edges with clips or sutures, and the rest of the operation, whether it be simply the introduction of a catheter, or the attack upon a stricture, is done in the dark. We therefore strongly advise that the procedure above described, in which the urethra is seen, the edges carefully picked up and held aside, and the field thoroughly exposed to view, be adopted. This is particularly true in stricture operations.

External urethrotomy without a guide is a term used to indicate an operation in which it has been impossible to pass a filiform or curved sound through a urethral stricture. In such cases, however, unless the stricture is in front of the penoscrotal juncture, it is easy to open the urethra upon a sound (or our special instrument) which has been passed down to the point of stricture. The technic is therefore the same as has been previously described, viz., opening the urethra upon the instrument and carefully catching the edges of the divided urethra with forceps or sutures. The attack upon the stricture will be described later on.

PERINEAL OPERATIONS FOR STRICTURE OF THE URETHRA

These vary very greatly, depending upon the location, character, multiplicity of the strictures, and the complications present. Where it is possible to pass a filiform and grooved sound, this should be done, as it may greatly facilitate the procedure. In such cases the urethra is opened upon the grooved sound, edges of the mucous membrane caught up, the point of a small knife inserted into the groove of the instrument, and forced slowly back into the strictured area. It is not desirable to use the large cutting instruments which were once employed, nor to carry the incision through the external sphincter or prostatic urethra into the bladder. These blind procedures, which were done with such rapid but fearful dexterity by the early urologists, were followed by hemorrhage, incontinence, extravasation, and other serious complications. Nor do we think it advisable to introduce the operator's forefinger through the external sphincter and prostatic urethra into the bladder. We have seen incontinence follow such forcible overstretching of the sphincteric mechanism. The passage of sounds even up to 30 or 34 F., may easily be carried out and is sufficient for complete dilatation. The use of the modern screw dilators (Kollman) is also to be recommended as sufficient for the purpose. After the urethra has been sufficiently dilated a catheter may be inserted, fastened in place by a transfixion stitch at the skin margin, and the superficial wound partly closed or packed. Strictures accompanied by extensive cicatricial mass usually require more than simple incision. In our experience excision of the fibrous tissue is very desirable and this should be carried out without excision of the mucous membrane. The operation which we prefer is shown in Fig. 913.

Excision of Strictures.—After a good wide exposure has been obtained, and the

strictured area has been widely divided, the extensive mass of scar tissue should be carefully excised on each side, leaving intact the strip of mucous membrane which intervenes between the normal anterior and posterior portions of the urethra (Fig. 913, *c*, *d*). This excision will leave a cavity which is surrounded by the more or less normal cavernous and muscular tissues of the bulbous urethra. A large catheter is then passed in the bladder through the urethra and the soft tissues are drawn together, fairly tightly, around the catheter with a continuous plain catgut suture. The perineal fascia is then approximated by a similar line

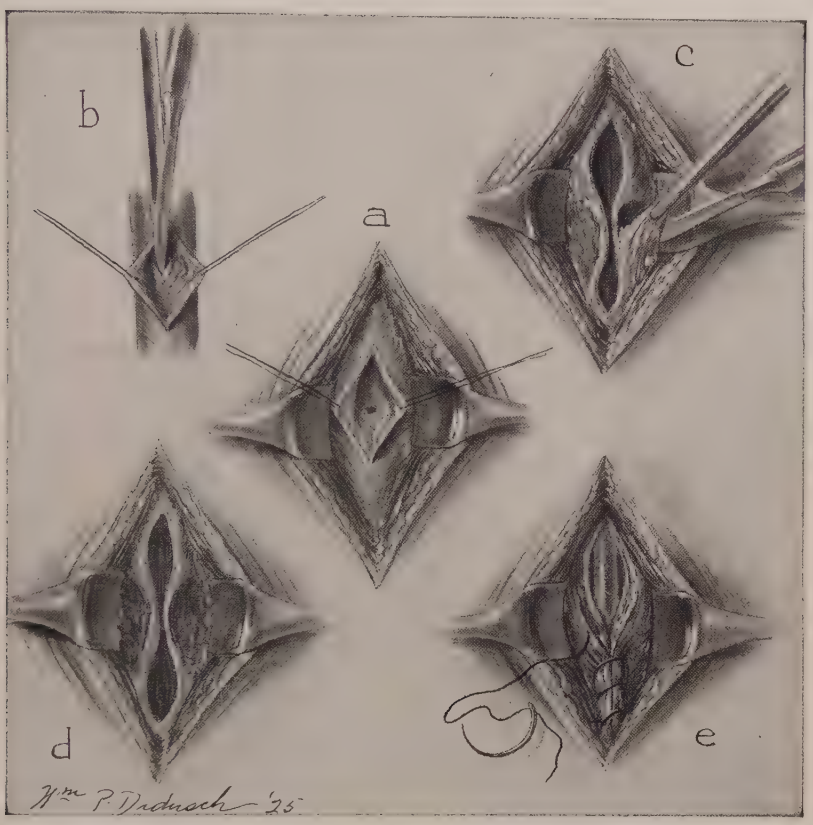


FIG. 913.—External urethrotomy for stricture: *a*, Urethra opened in front of stricture which is disclosed by passage of filiform. *b*, Filiform withdrawn, delicate grooved director introduced, and stricture divided with sharp bistoury. *c*, Strictured area opened, showing dilated urethra behind and mass of fibrous tissue on each side. Resection of this begun. *d*, Fibrous tissue has been resected, leaving narrow bridge of mucous membrane connecting normal anterior and posterior portions of urethra. *e*, With catheter in urethra soft parts are approximated over defect in urethra, which is completely closed. This is reinforced by a second layer of catgut sutures. Skin left open.

of suture, and the skin and subcutaneous tissues are closed completely, except at the anterior angle, where a small superficial antiseptic pack is inserted for drainage of the skin wound. The catheter emerging from the meatus is fastened in place and mild antiseptic treatment of the bladder several times daily carried out to prevent infection. The catheter is left in place for about a week unless suppuration or irritation requires early removal. Thereafter urethral dilatation with sounds should be carried out beginning about the twelfth day and repeated once every four or five days until cicatrization is completed and a normal large urethra is insured.

The rapidity with which the urethral mucous membrane will cover a defect after extensive excision of the scar tissue is remarkable. This natural replacement is so effective that the extensive plastic operations which have been described by Marion, Cabot, MacGowan, and others are rarely necessary. Likewise, complete resection with end-to-end anastomosis of the urethra has little or no place in perineal surgery, with the possible exception of those cases of extensive fibrous

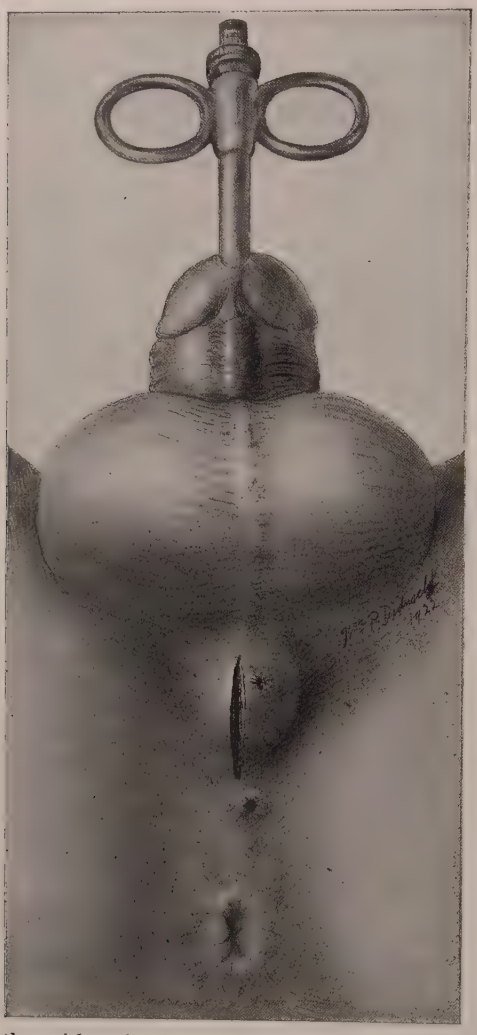


Fig. 914.—Stricture of urethra with perineal urinary fistulæ. Primary incision upon Young's urethrotomy staff. B. U. I. 9905.

tissue formation following rupture of the urethra and other traumatisms in which the ends of the sound urethra, anterior and posterior to the strictured area, are so widely separated as to render the restoration of continuity by natural processes extremely improbable. As Keyes remarks, "the only requirement for filling the gap in the urethral wall is to fix the two ends of the urethra as near together as may be and in such a position that a sound will readily enter the posterior end, for if subsequent passage of sounds is possible we may look for a happy outcome."

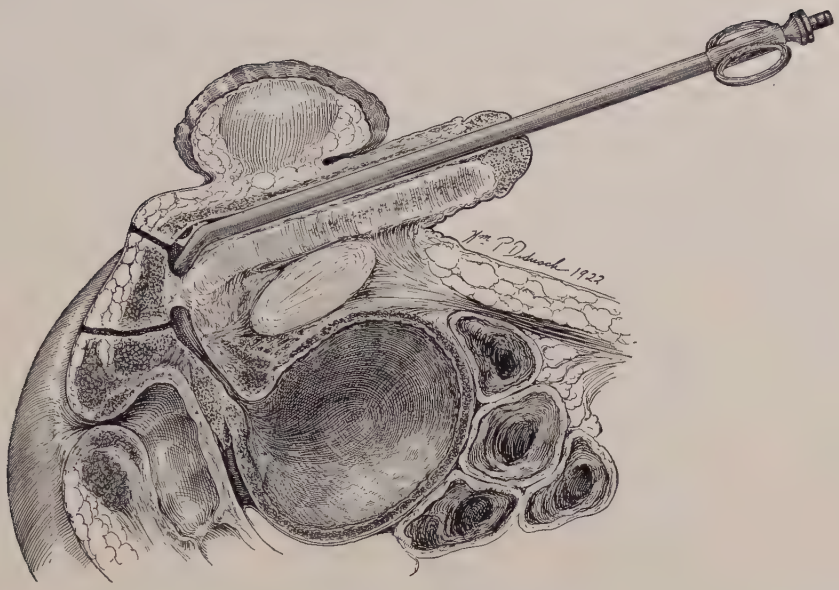


FIG. 915.—Longitudinal section showing location of stricture, fistulæ, and use of Young's urethrotomy staff. B. U. I. 9905.

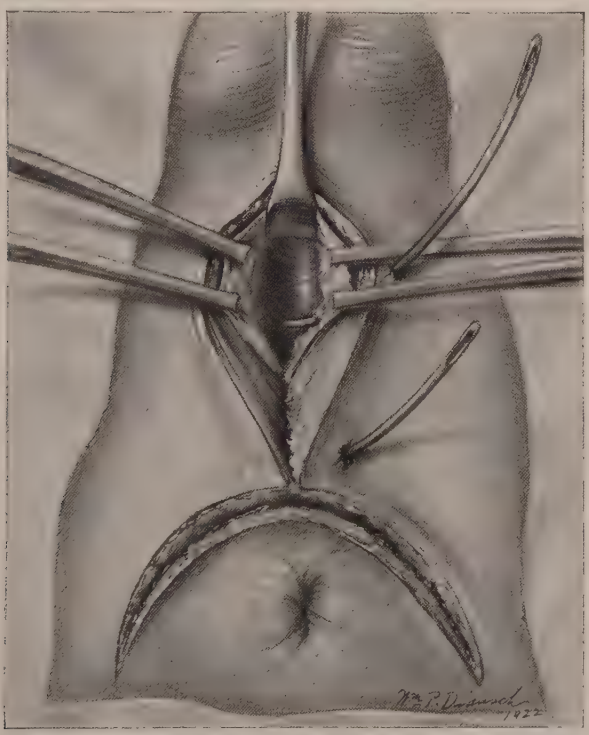


FIG. 916.—A very severe case of urethral stricture in which Young's perineal retrograde operation was done: Stricture of urethra, impermeable, with two perineal urinary fistulæ. Bulbous urethra opened. Probes in fistulæ. Lumen of urethra not found. Inverted U incision preparatory to exposure of membranous urethra and retrograde passage of sounds to disclose site of stricture and urethral lumen. B. U. I. 9905.

Marion's operation, according to Keyes, is applicable only to the treatment of rupture of the urethra. Keyes says:

The aim of Cabot's operation is to divide the stricture upon the floor of the urethra in the usual manner and to reunite the longitudinal incision by transverse suture, thus puckering the urethra, as it were, and enlarging the lumen of the stricture (Heinecke principle).

The steps of the operation are as follows: The urethra is steadied by a sound instead of a staff. The bulb is exposed in the usual manner, but not incised. The bulbocavernosus muscle is stripped away and the bulb itself separated from the corpora cavernosa for a space of at least 3 cm. The bulb is now opened over the point of the sound and the stricture incised in such a

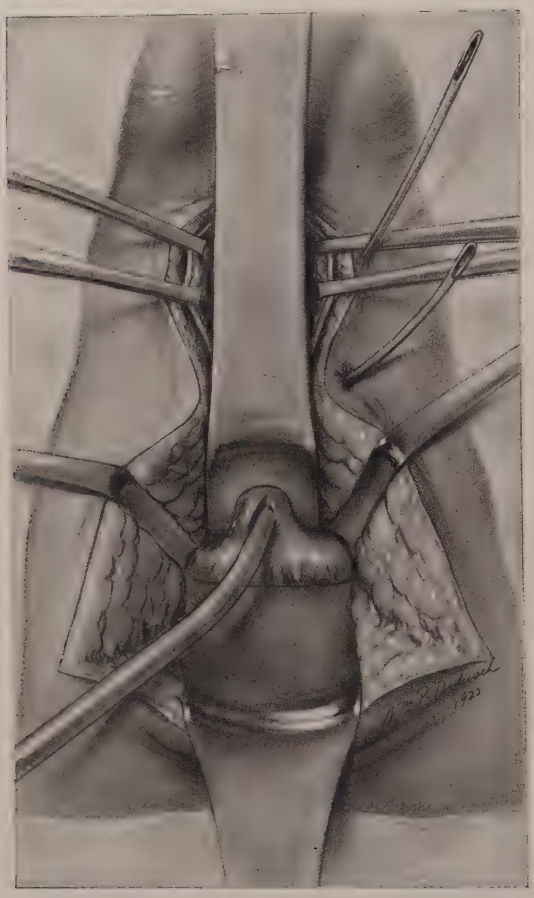


FIG. 917.—Exposure of membranous urethra and apex of prostate. Urethrotomy. Introduction of sound retrograde. B. U. I. 9905.

manner that the urethra is opened for a short distance behind as well as in front of it. Beginning at the tightest point of the stricture (*i. e.*, approximately at the middle of the longitudinal incision of the bulb) the adjacent edges of the mucosa and underlying corpus spongiosum are sutured transversely with fine catgut introduced on a curved intestinal needle. A small sound is left in the urethra while successive sutures are taken in each side and clamped, but not tied, until the whole wound has been caught in sutures running from before backward and calculated to close the wound transversely on the sound in the urethra. The sutures are then tied, beginning with the ones first introduced and ending with those central ones that approximate the anterior and posterior ends of the original incision. The drainage is provided by a small catheter introduced into the urethra at a point posterior to the incision in the stricture. The perineum is

sutured over the incision in the urethra; the small catheter left in place for two weeks; the bladder irrigated daily. Cabot's operation is obviously only applicable to relatively narrow strictures. In 7 or 8 cases it has given me better results than simple urethrotomy; but the urethra is much puckered by the operation and one must be extremely gentle in the first attempt to introduce sounds."

More recently MacGowan has published an article describing very extensive plastic operations upon the urethra. We have had no experience with such procedures, nor have we found them necessary. As remarked before, we believe that for a successful operative cure of urethral stricture through the perineum the

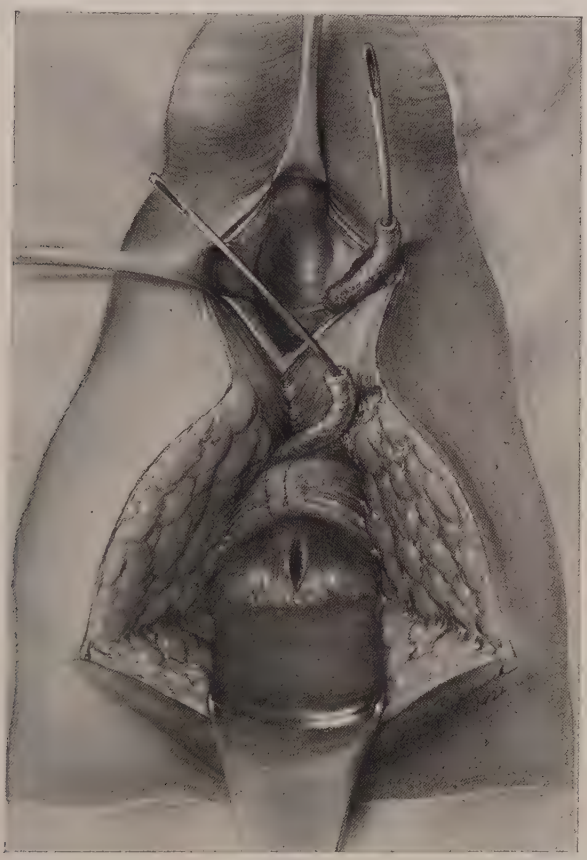


FIG. 918.—Impermeable stricture of urethra; two urinary fistulæ, retrograde operation from membranous urethra. Fistulous tracts are shown dissected free. The posterior tract passes beneath the transversus perinei muscles as shown in dotted line. B. U. I. 9905.

main points are an open operation with adequate exposure so that the operator may find the stricture, divide it, excise extensive scar tissue which may be present, being careful to preserve the mucous membrane, and closure of soft parts around the catheter, leaving to nature to repair the lack of mucous membrane, which she does with great rapidity and effectiveness.

Operation Upon Stricture Without a Guide.—This applies to cases in which it is impossible even to pass a filiform before operation. After the patient has been anesthetized an attempt should again be made with filiforms and whale-bone bougies to pass some instrument through the strictured area. If this is impossible,

the urethra may then be injected with a 1 per cent. solution of methylene-blue which should be milked back slowly but forcibly, until the solution passes through the strictured area into the posterior urethra. The anterior urethra should then be washed clean so that the wound is not stained when the urethra is opened by the method described above. The wound should be sufficiently long so that when the normal urethra in front of the point of stricture is held aside, a good view is obtained, while with filiform and probe the operator searches for the lumen through the strictured area.

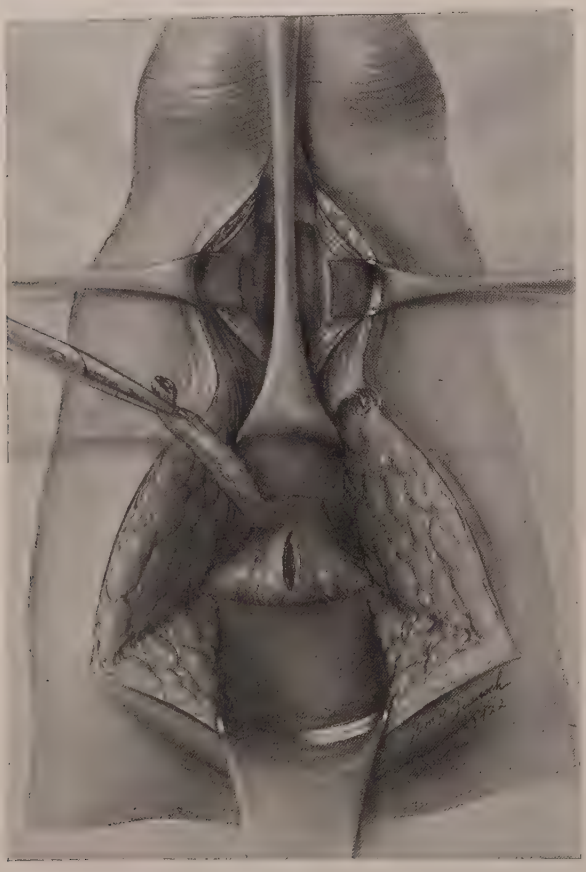


FIG. 919.—The posterior fistula has been brought out beneath the transversus perinei muscles, without dividing them, and dissected free to its origin at the membranous urethra, preparatory to excision. B. U. I. 9905.

In these cases one frequently finds marked irregularity, roughness, folds or pouches in the urethra anterior to the point of stricture, and occassional false passages. The lumen of the urethra is often considerably anterior to these pouches and eccentric, but with careful search it can usually be found and successfully probed. An excellent instrument for this purpose is a very fine, probe pointed, grooved director along which one may pass a fine bistoury and divide the strictured area. Every effort should be made thus to locate the urethral lumen. Where it is impossible after prolonged search to find it, Keyes strongly recommends transverse division with scalpel through the strictured area. He says that he has always

been able to find the blue-stained lumen when he has followed this procedure, and from that point passage of a filiform and probe into the deep urethra and bladder is a simple procedure. The remainder of the operation is as before described.

Extensive blind dissection or incision, transverse or otherwise, in search for the strictured lumen is certainly not advisable, as great destruction and severe complications may result therefrom.

In such a predicament the operator, unable to find the urethral lumen, may resort to either suprapubic or perineal retrograde passage of a sound to locate the urethra behind the strictured area.

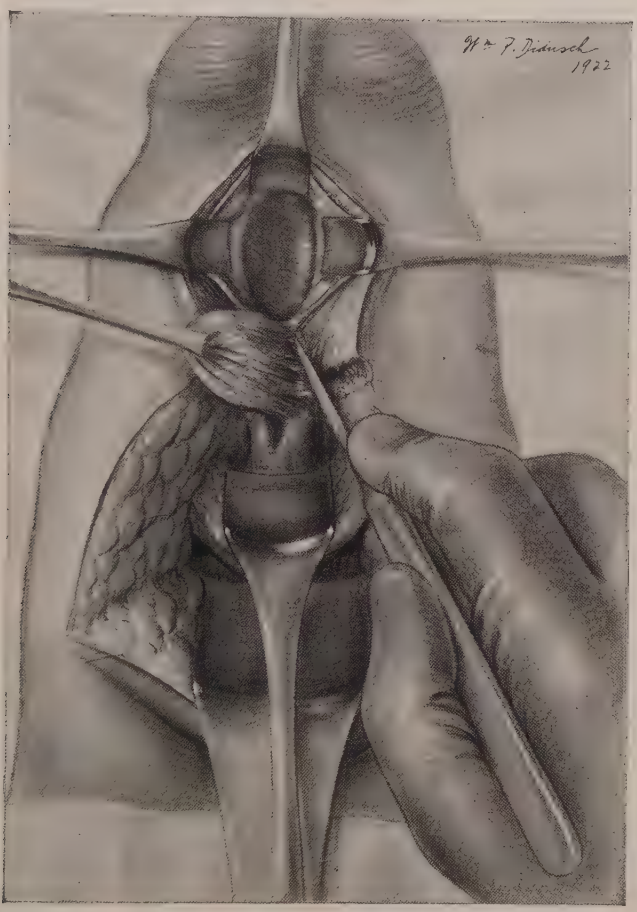


FIG. 920.—Excision of extensive scar tissue surrounding bulbomembranous region of urethra. The transversus perinei muscles are drawn backward, exposing the urethrotomy wound in membranous urethra. B. U. I. 9905.

Suprapubic Retrograde Catheterization.—A small suprapubic incision is made into the bladder, and a sound or catheter, preferably with a Guyon or Beniqué curve, is passed through the prostatic urethra until its beak can be felt by the operator's finger in the perineum. An incision is made upon this, and in so doing the strictured area is divided, the connection between the urethra anterior and posterior to the stricture opened up and the scar tissue excised, etc., as above described. Instead of carrying out this procedure, many years ago Cock advised

a blind puncture of the membranous urethra at the apex of the prostate through the median line of the perineum and the passage of a curved sound from this point to the stricture in the bulbous urethra. Samuel Gross stigmatized this as an operation that "only a knave or a fool would do."

In 1906 we[1] presented a *perineal retrograde operation* which we had used in impermeable stricture cases, the technic of which is shown in the accompanying illustrations taken from drawings, made at operation, of a very complicated case of impermeable stricture with two fistulæ (Figs. 914–922). As shown in Fig. 916, an inverted U incision was made at the lower angle of the perineal

Fig. 921.—After resection of fistulous tract and scar tissue of stricture anastomosis of anterior and posterior portions of urethra was made (roof only). B. U. I. 9905.

incision and the membranous urethra and apex of the prostate exposed as in our technic for perineal prostatectomy (Fig. 917). The location of the membranous urethra is a little more difficult, owing to the absence of the usual sound, but if injury of the rectum is feared this can be avoided by insertion of the finger into the rectum (we do not do this). Having exposed the membranous urethra and pushing the tissues back so that the apex of the prostate is seen, an incision may be readily made into the dilated urethra behind the point of stricture. The edges are then picked up with clip forceps and a sound passed anteriorly until the point of stricture is reached (Fig. 917). The lumen

[1] Young: Johns Hopkins Hospital Reports, 1906, xiii, 183–188.

is then disclosed, the strictured area divided, scar tissue and fistulæ, if present, excised (Figs. 918–920), catheter inserted, soft tissues drawn together to cover the defect (Fig. 922), and the fascia closed, as previously described. This operation has been carried out in many instances in our clinic with uniform success

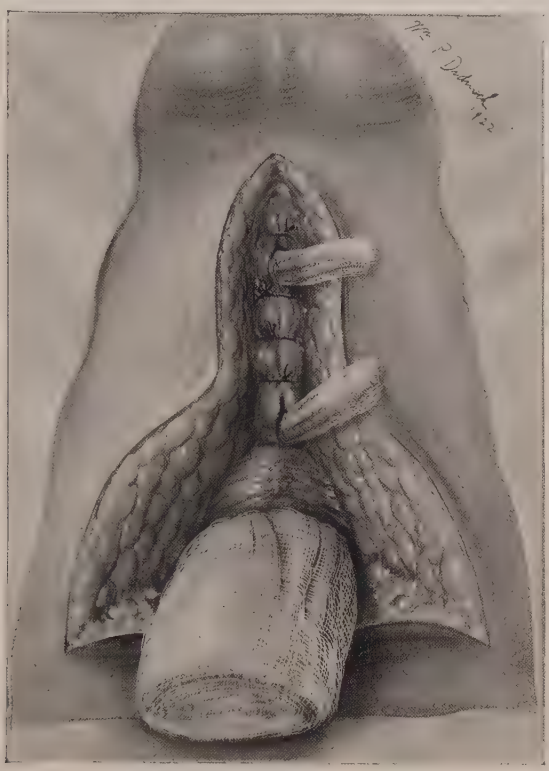


Fig. 922.—Muscles of bulb approximated over urethral anastomosis. Drainage supplied. B. U. I. 9905.

and we believe is not only far superior to suprapubic retrograde instrumentation, but also to blind mutilating dissection of the perineum in vain efforts to discover the site of an impermeable stricture.

EXCISION OF PERINEAL FISTULÆ

Perineal fistulæ form one of the most serious complications of stricture of the urethra, and may be so extensive and multiple as to require very extensive dissections. As remarked elsewhere they may penetrate in various directions through the perineum and also into more or less remote adjacent regions, scrotum, buttocks, and ischiorectal fossæ. In some instances they are tuberculous in nature and care must be taken not to produce a generalized tuberculosis. Before operation every effort should be made to clean up the infection of the urethra and fistulæ by antiseptic injections. Any abscess that may be present should be opened and treated before a dissecting operation is undertaken unless the conditions necessitate immediate operation. If a stricture can be dilated by filiforms, followers, and sounds this should preferably be done, the urethra and bladder be treated, and the fistula curetted with the hope of spontaneous cure. Where this

does not supervene, operation is indicated and varies according to the location, character, extent, and multiplicity of the fistulæ. In case of a single perineal fistula associated with stricture, it is usually found that the fistula communicates with the urethra immediately behind the point of stricture. Following of the fistula will therefore usually lead to the point of stricture, which is usually immediately in front of it, where it may be divided, excised, etc., as previously described. The fistulous tract should be excised with its fibrous wall (Figs. 923, 924), unless this leads to too extensive destruction, when partial curettage may suffice. Where the stricture passes through the external sphincter and triangular ligament, great care should be taken not to injure these important structures. Excision of the

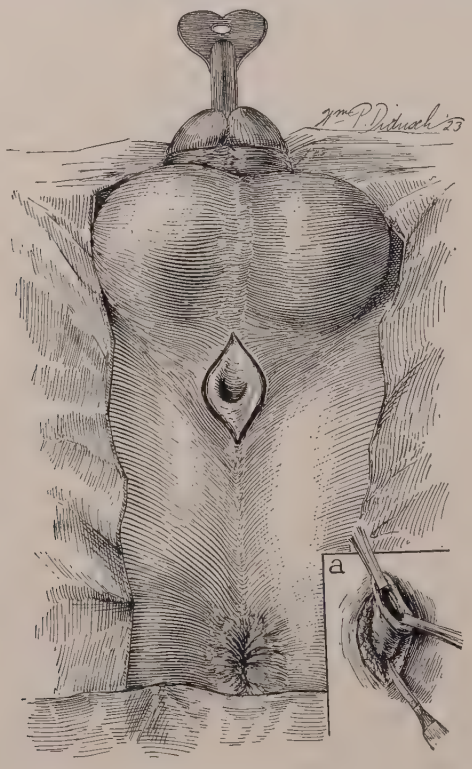


Fig. 923.—Perineal urinary fistula. Line of incision in skin. *a*, Dissection of tract. B. U. I. 11,102.

stricture down to sphincteric musculature and curettage beyond this point will usually suffice for a cure. When the strictured area leads into the perirectal and prostatic region it may be necessary to follow the fistulous tract back of the triangular ligament. An interesting case of this type is shown in Figs. 914 to 922. Note especially Figs. 918 and 919, where the isolated fistulous tract has been drawn out under the transversus perinei muscles without dividing them.

An abstract of the case illustrated follows:

B. U. I. 9905, age thirty-eight. Past history is negative and the patient denies gonorrhea. Two years before admission he fell, striking his perineum. This was followed by pain and some swelling, but no operation was required. One month later difficulty of urination commenced, followed by frequency and small stream. The difficulty increased until there was constant drib-

bling. External urethrotomy was done elsewhere about one year before admission here. As a result of this operation, the fistula remained open and the constant dribbling persisted. The situation as disclosed at examination is shown in Fig. 915, and the operation performed is well indicated in the other pictures. Convalescence uneventful except for an acute bronchitis. At the time of discharge the perineal wound was healed and the patient was voiding without difficulty in a large stream with perfect control and at intervals of several hours.

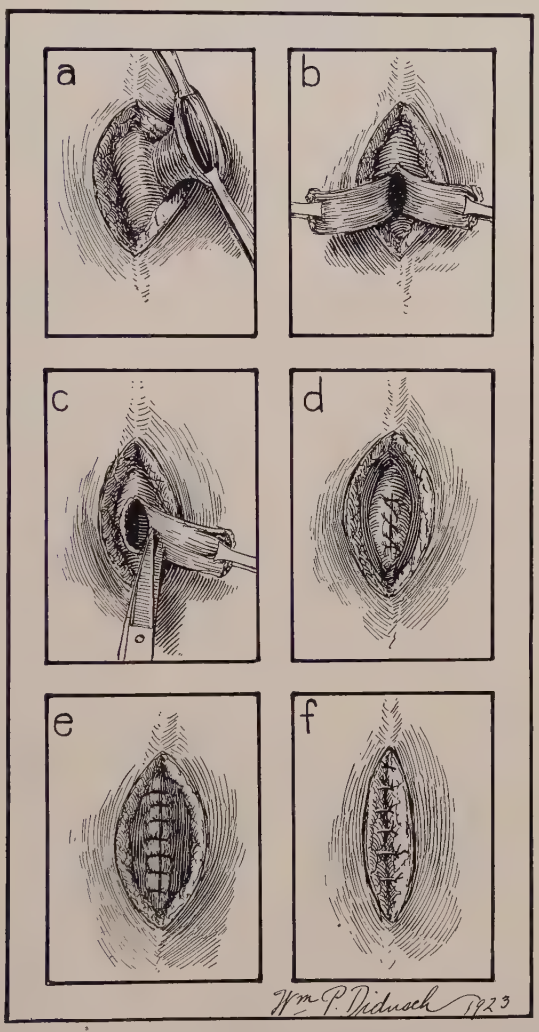


FIG. 924.—Operation for radical cure of perineal urinary fistula: *a*, Dissection of fistula. *b*, Fistulous tract split so as to allow inspection of juncture with urethra. *c*, Excision of tract at urethral margin. *d*, *e*, and *f*, Closure of fistula in three layers with catgut, skin left open for drainage. B. U. I. 11,102.

Where the fistula extends out into the adjacent regions of the scrotum, thighs, buttocks, etc., incision and curettage or complete excision, occasionally with closure, may be indicated. Where the fistula extends into the rectum, operation upon this portion should be deferred until the communications with the urethra have closed unless there be a definite recto-urethral fistula present in which a more extensive operation is required (see below).

OPERATION FOR RECTO-URETHRAL FISTULA

Recto-urethral fistula is a connection between the rectum and the urethra through which gas, urine, and feces may pass.

Preventive Measures.—As pointed out elsewhere, it may be the result of inflammation or traumatism. The traumatic cases are most often postoperative. Early in the days of "cutting for stone" injury of the rectum and resultant recto-urethral and rectovesical fistula formed a distressing complication. As a result of this accident, the operation of lateral lithotomy was devised, and the finger was usually inserted into the rectum to prevent injury. With the development of the operation for perineal prostatectomy, recto-urethral fistula again came into prominence, largely through carelessness, poor anatomic knowledge, and blind operations. With the development of the open operation, recognition of the importance of dividing the central tendon close to the bulb, the recto-urethralis close to the membranous urethra, and careful transverse section of the posterior layer of Denonvilliers' fascia before attempting to expose the posterior surface of the prostate, injury of the rectum was greatly reduced, but it still occurs in the hands of the occasional and the careless operator and unfortunately sometimes when care is taken.

As pointed out elsewhere, the close proximity of the rectum to the perineal structures, the bulb, the membranous urethra, and the posterior surface of the prostate makes it absolutely essential to know the anatomy of the region, to be able to recognize the component structures, and in making either blunt or sharp dissection, to take due care before taking each step. In operations on stricture of the urethra, especially with infiltration of the deeper portions and close adhesion of the rectum, care is necessary in the deeper dissection and in division of the stricture not to injure the rectum. In such cases, the insertion of a finger may serve to warn of too close approach to the rectal mucosa. In our retrograde operation for stricture through the perineum and in the operation for perineal prostatectomy as described in Chapter XVII, to avoid accident one must do an open operation, see and recognize structures and tissues, divide the central tendon close to the bulb, the recto-urethralis muscle close to the membranous urethra, and the fascia of Denonvilliers at the apex of the prostate and membranous urethra, in order to insure entrance into the space between the two fascias of Denonvilliers, which when once entered, facilitate so greatly the rapid separation of the rectum from the posterior surface of prostate and seminal vesicles, as described elsewhere. With care it is practically always possible to expose the membranous urethra and the prostate for the various operations which may be required without fear of injury of the rectum. In the presence, however, of fistula, extensive scar tissue, previous operative cicatrices, extensive periprostatic infiltration and adhesions, perineal operations upon the prostate may be rendered much more difficult, and in such cases it may be more desirable to operate suprapubically if possible. Previous perineal operation is often an indication for the suprapubic route to be chosen, just as a previous suprapubic operation often indicates a perineal for the next method of attack. In the closure of perineal operations it is important to bring together the levator muscles to their position in front of the rectum, not only to restore the musculature to its normal position, but to protect the rectum against postoperative straining at stool or pressure from packing, both of which may cause rectal breakdowns.

Operation at Time of Injury.—When the patient is brought into the hospital after an accident in which the rectum and urethra have been torn, the operation should be twofold. First, to restore the ruptured tracts and, second, to drain the bladder suprapubically. If the rectum is injured during the operation for perineal prostatectomy, the procedures to be taken vary with the case:

(*a*) The rectal tear is discovered before the urethra is opened. In such cases it is important to go no further with the operation upon the urinary tract (prostatectomy, urethral stricture, etc.), but to immediately close the rectum in layers, preferably with catgut, dilate the external sphincter, and bind up the bowel movements for a week. If the patient is in good condition and prostatectomy is indicated, suprapubic operation may be carried out simultaneously, care being taken not to break through the posterior capsule of the prostate, as recto-urethral fistulæ have occurred after suprapubic prostatectomy.

(*b*) Rectal tear discovered after opening the urethra, but before removal of the prostate. Here the indications are the same as described in the preceding paragraph. It is best to close both the rectum and the urethrotomy wounds and to remove the prostate suprapubically.

(*c*) The rectal tear discovered after perineal prostatectomy, before closure of wound: Indications here are to supply suprapubic drainage, to arrest hemorrhage by means of the Davis bag; to avoid perineal packing, to close the rectum and perineal wound as completely as possible with only a small tube drain, and having dilated the sphincter, to tie up the bowels by means of lead and opium pills. One week later liquid paraffin is given and then several hours later castor oil and salines so as to have abundant free movements without straining. The suprapubic drainage is maintained until the rectal wound is firmly healed (two to three weeks).

Radical Cure of Recto-urethral Fistula.—Historical note: Very early in the development of our operation of conservative perineal prostatectomy, the problem of recto-urethral fistula occurred. In the ninth case hemorrhage occurred on the night following the operation, an assistant forcibly packed the wound with several additional strips of gauze, and in so doing injured the rectum, with a resulting recto-urethral fistula. A second operation was performed five months later in which the scar tissue was excised, the rectal and urethral openings closed separately and the bladder drained through a bulbo-urethrotomy wound. The rectal wound broke down on the seventh day, but the urethral wound healed. The rectal wound finally closed on the fifteenth day and the bulbous urethrotomy fistula on the twenty-first day.

The next case operated by the same technic did not do so well, and it was evident that the retained catheter in the urethra was a source of irritation, suppuration, and probably led to the breakdown of the urethral sutures. At a third operation in this case suprapubic cystostomy was provided and the rectal and urethral fistulæ again closed separately through the perineum, with resultant *per primam* healing. We subsequently reported this technic for the cure of recto-urethral fistula[1] citing 7 cases, in which the operation had been entirely successful in 5. In 2 cases, pinpoint recto-urethral fistulæ were present. In these publications we first laid stress upon the importance of suprapubic drainage, stating that "it

[1] Young: Recto-urethral Fistulæ, Description of New Procedure for Their Prevention and cure, Johns Hopkins Hospital Reports, 1906, xiii, 477–484. Also Journal of American Medical Association, February 4, 1905.

seems evident that the best operation for recto-urethral fistula is preliminary suprapubic cystotomy followed by closure of rectal and urethral fistulæ through the perineum." Subsequent experience with our operation as above described continued to give us occasional failures, and on this account, in conjunction with Dr. Harvey Stone, we modified the operation by completely excising the rectal fistula along with a cuff of rectal mucosa. This procedure, which has since been known as the Young-Stone operation, was first published in 1913.[1] In discussing this operation, we stated: "It will be seen that there are four essential principles in this procedure. The first is the protection of the repair from leakage and muscle spasm by diverting urine from the urethra through suprapubic drainage. The second principle is the complete ablation of the damaged portion of the rectal wall and the reposition of perfectly sound mucosa quite to the skin edge. The third element is the closure of the urethral orifice, and the final essential is the interposition between rectum and urethra of a solidly built up body and repair of the sphincter muscles." Before publishing this operation we searched the literature and presented our findings as follows:

Ziembicki, in 1889, loosened the rectum from its lower attachments, then rotated the rectum to one side so as to bring the two orifices out of line with each other. Segond applied the principle which we have used of pulling down the rectum in attacking rectovaginal fistula. Tedena reported having successfully operated on 2 cases of recto-urethral fistula by dilating the anus, dissecting up a cuff of rectal mucosa, closing the urethral orifice thus exposed, and then pulling the rectal mucosa down so that the rectal orifice of the fistula is brought to the anal margin. Elting has adopted an analogous attack upon fistula in ano. Unquestionably, we are not the first to realize the applicability of the Whitehead principle to the cure of such fistulæ (as we thought we were), but we desire to emphasize the importance of the other steps involved in our procedure.

Since making this report we have discovered through a personal communication from Dr. H. Wildbolz of Berne, Switzerland, that he had also applied the Whitehead principle in excising a recto-urethral fistula.[2] His operation, as described, consisted of a median perineal and a circular incision around the anus; division of the rectal sphincter and anterior wall of the rectum; separation of the rectum from the urethra and prostate until the rectum was freed for a centimeter above the fistulous opening. Then it was easy to draw down the rectum and to amputate above the fistula and close by suturing the rectal mucosa to the anal skin. The divided sphincter was then approximated, the urethral fistula resected and then closed, and the perineal wound closed with light drainage. A retained catheter in the urethra was inserted to provide for urinary outflow. Wildbolz reported only 1 case. In this the result was excellent except that the patient had partial incontinence of feces. He has made no further publication, but stated in a letter in 1920 that he is satisfied with the result.

In a further report with H. B. Stone,[3] we reported 11 cases in which the technic described by us had been employed, with the following comment as to results obtained:

Each of these 11 cases had been subjected to one or more previous operations, rendering the whole region abnormal and extensively scarred. In 3 cases the sphincter ani had been previously

[1] Young, H. H., and Stone, H. B.: Operation for Urethral-rectal Fistula, Report of 3 Cases, Transaction American Association of Genito-Urinary Surgeons, 1913.

[2] Monatsberichte für Urologie, 1906, xi, Heft 3.

[3] Journal of Urology, 1917, i, 289–317.

damaged, so that to the fistula itself was added disturbance to the rectal outlet. In all of these cases, with the exception of Case 7, belonging to a class admittedly recalcitrant to treatment, and indeed declared by the older writers to be well-nigh hopeless for betterment, a most gratifying degree of success was obtained. In these operations the rectal sphincter was divided in exposing the fistulous tract and subsequently sutured, and several of these cases presented a slight impairment of the anal sphincter and temporary incontinence of feces after the operation. In all but 1 case the recto-urethral fistula was apparently cured.

Subsequent experience with this operation has led us to modify it in several particulars, and the operation as now performed by us, differs materially

Fig. 925.—Operation for the cure of recto-urethral fistula. Sagittal section showing the condition usually present. The incision for the operation is indicated by the dotted line. The fistula after perineal operation usually enters the membranous urethra as shown.

from the operation published in conjunction with Dr. Stone. In some of the more difficult cases, with very extensive masses of perirectal and periprostatic scar tissue, it was found very difficult to draw down the deeper portion of the wound and to separate the rectum successfully from the posterior surface of the prostate above the tract of the recto-urethral fistula. It was then found of great advantage to insert our prostatic tractor through the fistulous tract into the bladder and to use this to draw down the prostate. This not only drew the deeper portion of the wound closer to the surface, but it gave a means of counterpressure

against which to work. Subsequently, we discovered that in some cases we could employ our long urethral tractor without going through the rectum or perineum[1] and in recent cases this method has been used very successfully.

The operation we now employ is described as follows: (1) Suprapubic drainage. With the patient on our special urologic table with the legs separated and hanging over the side bars covered with rubber tubing, the head is depressed so as to give the Trendelenburg position. The bladder is filled with air and a suprapubic opening made through a small median line incision. The bladder neck and internal sphincter are examined, and in case of incontinence the bladder is opened more widely and our special operation for incontinence carried out (excision of the mucous membrane from the lateral and posterior portions of the orifice and approximation of the muscles thus tightening the prostatic orifice). With a dePezzer catheter suprapubic drainage is provided. The bladder is closed around the tube with catgut and sutures of silver wire approximating skin, fascia and recti muscles inserted. (2) The patient is placed in the perineal prostatectomy position by elevating the legs with the side bars and carrying the patient upward by turning the crank operating the rack and pinion movement (which forces the shoulder-rests upward and at the same time works the perineal elevator). The rectal sphincter is dilated and the perineum and rectum thoroughly cleaned. A racket-shaped incision is usually made, starting in the median line about 2 inches in front of the mucocutaneous juncture (Fig. 926). Scar tissue in the perineum is excised and followed well down to its juncture with the prostatic urethra. The external sphincter is carefully preserved, thus differing from the technic which we published with Dr. Stone. The rectal mucosa and submucosa are stripped up from the sphincter and rectal muscles, exactly as is carried out in the Whitehead operation for hemorrhoids. Owing to the marked adhesions anteriorly, it is usually wise first to carry the dissection well up posteriorly and laterally, using the typical hemorrhoid clamps to make traction upon the cuff of bowel and taking care not to make this too thin and to stop hemorrhage. If a perineal urinary fistula is present, this will usually be found to pass in front of the sphincter, and should be completely dissected out without injuring the latter. When this has been done, the sphincter can then be drawn forward and the cuff of rectum separated from it, while the dissection proceeds upward in freeing the rectal wall from the prostate. About this time it is well to insert a prostatic tractor. This may be done either through the urethra, using a long urethral model (Fig. 927), through the perineum, or through the recto-urethral fistula, depending on which seems most applicable for the case. The urethral tractor is more satisfactory in some cases, in that it leaves the operator free to excise the fistula into the urethra, and the tractor not only draws the deeper structures toward the surface but by traction and leverage

Fig. 926.—Radical operation for recto-urethral fistula. Racket shaped incision in perineum and around anus at mucocutaneous juncture. B. U. I. 2708.

[1] Young: First published in Keen's Surgery, vol. viii, 589, 590.

it forms a counterpressure against which to work. The short tractor, introduced into the urethral fistula either through perineum or rectum, has the advantage of greater mobility and in some cases has been preferable to the urethral tractor. Some form of traction, however, is very helpful.

When the rectum has been freed up to the point of the fistula and on each side as far as possible, the fistulous tract is divided transversely, and by blunt or sharp

FIG. 927.—Radical operation for recto-urethral fistula with Young's long urethral tractor inserted and opened out. B. U. I. 2708.

dissection the rectal wall separated, if possible, at least 2 cm. higher up, so as to have abundant tissue to draw down. We found it preferable not to divide the anterior wall of the rectum (as done by Wildbolz), but to preserve its continuity as much as possible so that when traction is made the fistulous opening will appear below the level of the anal skin. A broad healthy surface of rectum is thus presented against the urethral fistula.

The next step is to close the urethral opening, and this is done after carefully

excising the mucous membrane and scar tissue. Two or three layers are usually desirable, catgut being employed and the boomerang needle-holder used to secure good apposition, as shown in Fig. 928. The object of these sutures should be, first, to approximate the mucous membrane, then the prostate and periprostatic tissue and then muscle, so as to form a bulky mass of sutured tissues between prostatic urethra and rectum.

If the anal sphincter has been injured or divided intentionally or otherwise, it should be repaired, tightened, or approximated with catgut sutures before closing the rectal wound. The closure of the rectum follows the time-honored principles

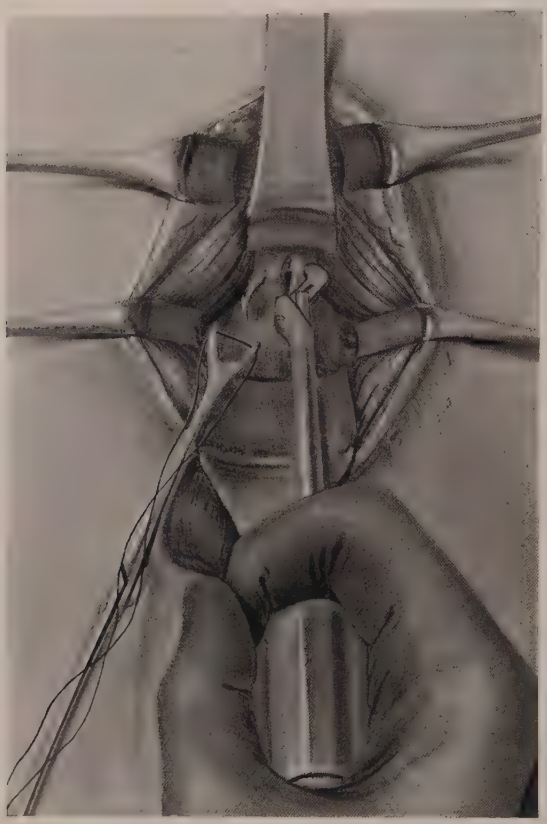


FIG. 928.—Radical operation for recto-urethral fistula. Closure of urethral opening after excision of scar tissue. First layer of sutures is being placed with boomerang needle-holder (plain catgut). B. U. I. 2708.

of the Whitehead operation. Four cardinal sutures of buried chromicized catgut are first inserted to draw the rectal wall outward to the subcutaneous tissues, external to the sphincter. The rectal cuff is then excised, taking with it the fistulous tract (Fig. 929), and the rectal mucosa is approximated with interrupted sutures of fine catgut to the anal skin, great care being taken to have good approximation, so that granulating areas are avoided. The perineal skin and subcutaneous tissues are approximated with sutures of catgut, silk, or metal clips (Fig. 930), leaving a very small area for a minute rubber tissue drain into the depths of the perineal wound. This is treated lightly with antiseptics. No urethral drainage is employed.

Subsequent Treatment.—Great care is taken to maintain good suprapubic drainage. An evacuating apparatus may be employed or, if the bladder is sterile, the irrigating decompression apparatus can be used. The patient is given lead and opium pills to tie up the bowel movements for a week, at which time purgatives are given. It is very important to soften up the fecal mass by the use of liquid paraffin and saline purgatives before finally moving the bowels with a good purgative of castor oil. The perineal drain is usually removed within three to four days,

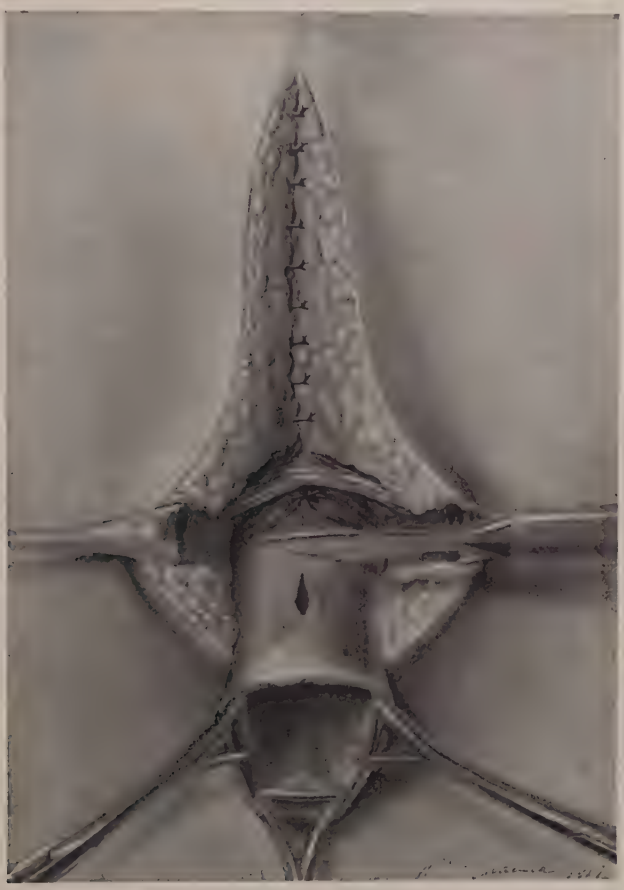


Fig. 929.—Radical operation for recto-urethral fistula. Urethral opening has been closed in three layers in front of and beneath rectal sphincter which has been preserved intact. Rectal cuff, freed and drawn down, is being amputated above rectal fistula. In this case external sphincter has been repaired for incontinence of urine. B. U. I. 2708.

care being taken by mild antiseptic treatment to keep the wound from becoming infected. The suprapubic catheter drain is removed at the end of two weeks and the fistula allowed to heal. If complete incontinence of urine has been present, as in one of our cases, in addition to the repair of the internal sphincter and the prostatic orifice as above described, the external sphincter and muscular structures in the triangular ligament should be repaired after excision of scar tissue, as is described in our typical radical operation for incontinence of urine. This procedure was carried out in the following case:

B. U. I. 2708, man aged thirty-one, with a history of chronic painful prostatitis and several operations through the perineum, the last of which had resulted in a recto-urethral fistula and incontinence of urine. Examination showed a large recto-urethral communication, an internal sphincter dilated and torn posteriorly, and the membranous urethra dilated and irregular with scar tissue posteriorly. The recto-urethral opening was large and patent, feces passed into the urethra and urine into the rectum and the patient was in great distress, was totally incontinent and suffered great pain. Operation was carried out as above described. Through the suprapubic wound, the widely dilated irregular prostatic orifice was exposed, the scar tissue excised, and the wound closed with transverse sutures of catgut, thus reducing the urethral orifice to a very small opening anterior to the line of sutures. Through the perineum a large mass of scar tissue was excised, including a portion of the membranous urethra and surrounding cicatrix. Good muscle was obtained and after closure of the fistulous opening into the prostatic urethra and resection of the cuff of rectal wall with the rectal fistulous tract, the membranous urethra was closed and the external sphincteric muscles repaired by approximating the muscle structures in two or three layers with catgut. This was done without injury to the rectal sphincter. The rectal cuff bearing the fistula was excised and the perineal and anal closure was performed as

FIG. 930.—Radical operation for recto-urethral fistula. Final closure of rectum after placing four cardinal subcutaneous traction stitches.

above described. The result obtained was excellent. Neither the rectal nor the urethral wounds broke down. Urinary control was restored. There was no rectal incontinence and the patient now, seven years later, has normal urination and defecation; no incontinence, no fistula, but he still suffers with a painful prostatitis (Figs. 926–929).

Another interesting and complicated case was the following:

B. U. I. 8618, E. L., aged nine years, admitted February 5, 1920, complaining of recto-urethral fistula following an accident six months previously. The boy was run over by a truck, fracture of pelvis resulting, with rupture of urethra and extensive abdominal hematoma. Condition grave. Suprapubic and perineal operation; discovery of rupture of urethra and rectum. Suprapubic and urethral drainage. Ultimate result: Complete occlusion of membranous urethra, recto-urethral fistula, suprapubic fistula. Urine passes also into the rectum. Examination: Markedly depressed scar present in perineum in front of anus, in center of which is a urinary fistula (Fig. 932). Rectal examination shows a depressed scar, site of rectal fistula. At base of

penis is a scar containing a fistula surrounded by a large amount of scar tissue. An instrument passed into urethra meets with obstruction in membranous urethra. There is a suprapubic fistula present through which urine escapes. Operation, February 11, 1920: Young. Radical operation to cure recto-urethral and perineal fistulæ and stricture of deep urethra. Operation previously described carried out. Extensive scar tissue around suprapubic fistula excised and fistula enlarged. The rectal cuff was drawn down, fistula divided, edges excised. Investigation showed that prostatic and membranous urethra were not in line and between the two was a mass of scar tissue completely obliterating urethra, probably the result of rupture at apex of prostate. With scalpel it was easy to break into septum, separating membranous and prostatic urethra and excise scar tissue, forming satisfactory communication between membranous and prostatic urethra. Prostatic tractor passed through fistula into bladder, facilitating deep dissection of recto-urethral

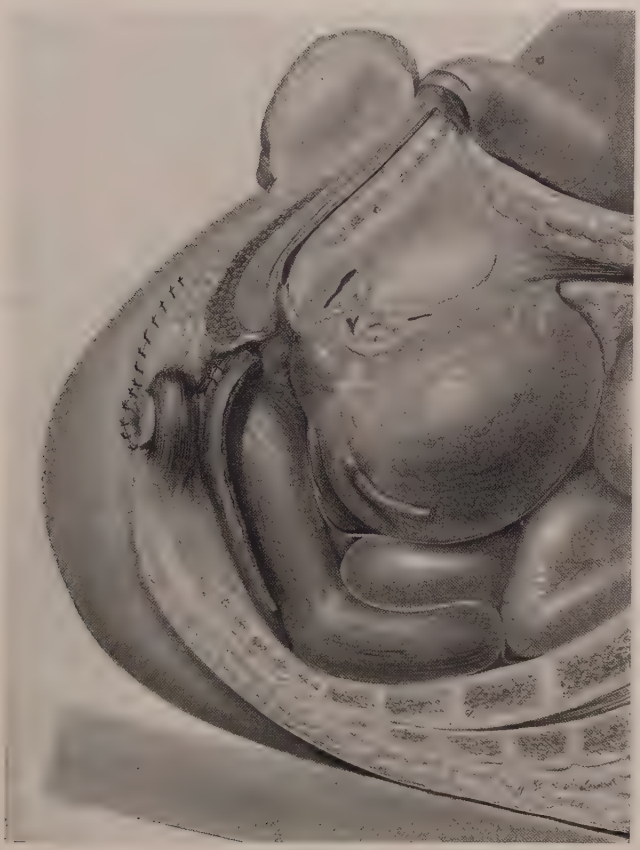


FIG. 931.—Radical operation for recto-urethral fistula. Sagittal section after completion of the operation showing the various layers of sutures in the urethra, the levator ani, the sphincter ani, and the mucocutaneous sutures joining the rectum to the skin. The sphincter ani has not been cut.

fistula, which was completely excised. Fistula was then closed with chromicized catgut, using the boomerang needle-holder. Two layers of mattress-sutures were employed. Rectal cuff was then drawn down and excised, removing fistula. Closure as previously described. Perineal fistula in front of triangular ligament excised, but not closed. Catheter placed through urethra into bladder for drainage on account of resection of stricture. Convalescence very satisfactory. Urethral catheter removed on the ninth day. No breakdown of rectal wound. February 26th, condition excellent. Perineal wound almost healed, no urinary or fecal drainage. Urinary control good. Nearly all urine passes through meatus. Urination frequent and painful. *x*-Ray shows large calculus in bladder (probably there on admission, but not detected on account of inability to cystoscope).

April 11th, suprapubic lithotomy. Although suprapubic scar tissue was extensive, bladder

was easily opened, stone about 2 cm. in diameter removed in fragments. Convalescence satisfactory, patient discharged. April 19th, condition excellent. Perineal wounds closed. No recto-urethral fistula. June 8th, two months since operation, result excellent. No recto-urethral or perineal fistula. Filiforms and No. 22 Le Fort follower easily passed into bladder. General condition excellent.

The use of a mass of fat interposed surgically between the rectum and urethra has been proposed by someone as a cure for recto-urethral fistula. This procedure has been tried once in this clinic without success, as shown in the following case:

Use of a graft of fatty tissue in an attempt to cure recto-urethral fistula. Failure. Fat expelled. B. U. I. 9178. L. S., aged fifty-five, admitted October 30, 1920. Prostatic hypertrophy of moderate size. November 16th, operation, Dr. J. Perineal prostatectomy. Unfortunately, no note recorded as to condition of rectum. There was no evidence of rectal fistula for a month, when fecal matter began to pass through perineal fistula. Sounds had been passed through urethra and it is possible that rectum was injured. Operation, January 14, 1921, Dr. G. Urethral retention catheter. Wound reopened, perineum dissected until fistulous opening in rectum was exposed. Urethra then freed from rectal opening, which was curetted. No attempt made to suture fistulæ. Incision made along one buttock and a piece of fat 7 x 5 x 1.5 cm. removed by

FIG. 932.—Showing large depressed scar of perineum containing fistula communicating with both rectum and urethra. B. U. I. 8618.

dissection and wound closed with silk sutures. This mass of fat was then placed in the perineal wound between rectal and urethral fistula and was sutured in position with catgut. A small pack of iodoform gauze was placed in the wound, extending to the mass of fat. The perineal wound was partly closed. January 16th, doing well, iodoform pack removed. January 24th, castor oil given. Feces came out freely from perineal wound and from urethra. January 25th, mass of necrotic fat extruded from wound today. January 30th, urethral retention catheter replaced. February 19th, patient discharged, recto-urethral fistula present. Unimproved by operation.

Remark: We have never had any confidence in this procedure, and the result obtained by another member of the staff has convinced us that this method is not worthy of adoption.

Summary: Number of cases in which radical operation for recto-urethral fistula was performed, 17. Cause: Perineal prostatectomy, 9; suprapubic prostatectomy, 2; prostatic abscess, 4; perineal lithotomy, 1; fracture of pelvis, 1. Previous attempts to close fistula made in 12 cases (often repeated several times). Condition: Gas or feces into urethra and urine into rectum in all cases. Incontinence of urine, 1; of feces, 1. Results: Recto-urethral fistula cured in all but 1 case, and in this is very small—greatly improved. Perineal urinary fistula cured in all cases but 3, and in these minute and with no rectal connection. Although

TABLE 185

Operation for Radical Cure of Recto-urethral Fistula: Seventeen Cases

B. U. I. No.	Age.	Cause of fistula.	Previous operations.	Condition.	Operation.				Results.					
					Supra-pubic drain.	Urethra closed.	Rectal cuff excised.	Rectal sphincter divided, sutured.	Recto-urethral fistula.	Recto-perineal fistula.	Urethral perineal fistula.	Rectal control.	Urine control.	Time followed. Remarks.
2,269	69	Suprapubic prostatectomy.	Punch, suprapubic prostatectomy.	Mict. q. 2h. Urine in rectum.	Yes.	Yes.	Yes.	Yes.	No.	No.	No.	Good.	Good.	Eleven years, result good.
2,708	31	Perineal prostatectomy.	Plastic to close fistula.	Gas in urethra, incontinence of urine.	Yes.	Yes.	Yes.	No.	No.	No.	No.	Good.	Good.	Eight years cured, no incontinence.
2,941	47	Prostatic abscess.	Plastic to close fistula.	Gas in urethra.	Yes.	Yes.	Yes.	Yes.	No.	No.	No.	Good.	Good.	Eleven years, well.
3,448	26	Perineal prostatectomy.	Plastic to close fistula.	Feces through urethra, urine through rectum.	Yes.	Yes.	Yes.	Yes.	No.	No.	No.	Good.	Good.	Six years, excellent result.
3,518	23	Perineal lithotomy.	Four plastics, failures.	Urine in rectum. Rectal incontinence.	Yes.	Yes.	Yes.	Yes.	No.	No.	No.	Good.	Fair.	Six years, urine incontinenc slight.
4,212	76	Perineal prostatectomy.	P. P.	Feces in urethra.	Yes.	Yes.	Yes.	Yes.	Yes.	No.	No.	Good.	Good.	Five years, no fistula. Eight years, slight fistula.
4,304	52	Perineal prostatectomy.	P. P.	Recto-urethral fistula.	Yes.	Yes.	Yes.	Yes.	No.	No.	No.	Good.	Good.	Two months, result perfect.
4,678	35	Puncture prostatic abscess.	None.	Gas in urethra, urine in rectum.	Yes.	Yes.	Yes.	No.	No.	No.	No.	Impaired slightly.	Good.	Four years, no fistula.
4,996	50	Perineal prostatectomy.	Two plastics, failures.	Gas in urethra, urine in rectum.	Yes.	Yes.	Yes.	Yes.	No.	No.	Yes.	Good.	Good.	Abscess in perineum six months later.
5,144	48	Prostatic abscess incised by rectum.	Two attempts to close fistula.	Gas in urethra, urine in rectum.	Yes.	Yes.	Yes.	Repaired.	No.	No.	Small.	Good.	Good.	At operation old abscess cavity found.
5,671	67	Perineal prostatectomy.	None.	Gas in urethra, urine in rectum.	Yes.	Yes.	Yes.	Yes.	No.	No.	No.	Good.	Good.	Excellent result.
6,781	50	Perineal prostatectomy.	Immediate plastic failed.	Gas in urethra, urine in rectum.	Yes.	Yes.	Yes.	No.	No.	No.	Yes, slight.	Good.	Good.	Minute urinary fistula at margin of anus.
6,079	35	Prostatic abscess.	Closure attempted 5 times.	Gas in urethra, urine in rectum.	Yes.	Yes.	Yes.	No.	No.	No.	No.	Good.	Good.	Letters returned, result good on discharge.
8,618	9	Traumatic fracture of pelvis.	Attempted closure through perineum.	Gas in urethra, urine and gas through perineum.	Yes.	Yes.	Yes.	No.	No.	No.	No.	Good.	Good.	Complicated case, result excellent.
10,019	69	Abscess of wound following P. P.	P. P.	Gas in urethra, urine through perineum.	Yes.	Yes.	Yes.	No.	No.	No.	No.	Good.	Good.	Patient died two and a half months after operation from septicemia.
10,591	66	Perineal prostatectomy.	P. P.	Urine in rectum, gas in urethra.	Yes.	?	Yes.	No.	No.	No.	No.	Good.	Good.	Ultimate result excellent.
11,734	63	Suprapubic prostatectomy.	Two attempts to close.	Gas in urethra, urine in rectum.	Yes.	Yes.	Yes.	No.	No.	No.	No.	Good.	Good.	Followed one year. Result excellent.

the rectal sphincter was divided and repaired in 8 cases, none had incontinence of feces afterward. In 1 case in which it was not divided or repaired, slight incontinence of feces is present. Perfect urinary control is present in all.

Conclusions.—Our more recent technic, using the long and short prostatic tractor, preserving the rectal sphincter, supplying suprapubic drainage, and, if necessary, suturing divided vesical and urethral sphincters (to cure incontinence) is apparently an entirely satisfactory method of radically curing these very complicated and hitherto almost incurable cases.

OPERATIONS FOR PERI-URETHRAL ABSCESS

As stated elsewhere, they vary greatly as to their origin and location and the surgery required. Not infrequently they rupture into the urethra and heal spon-

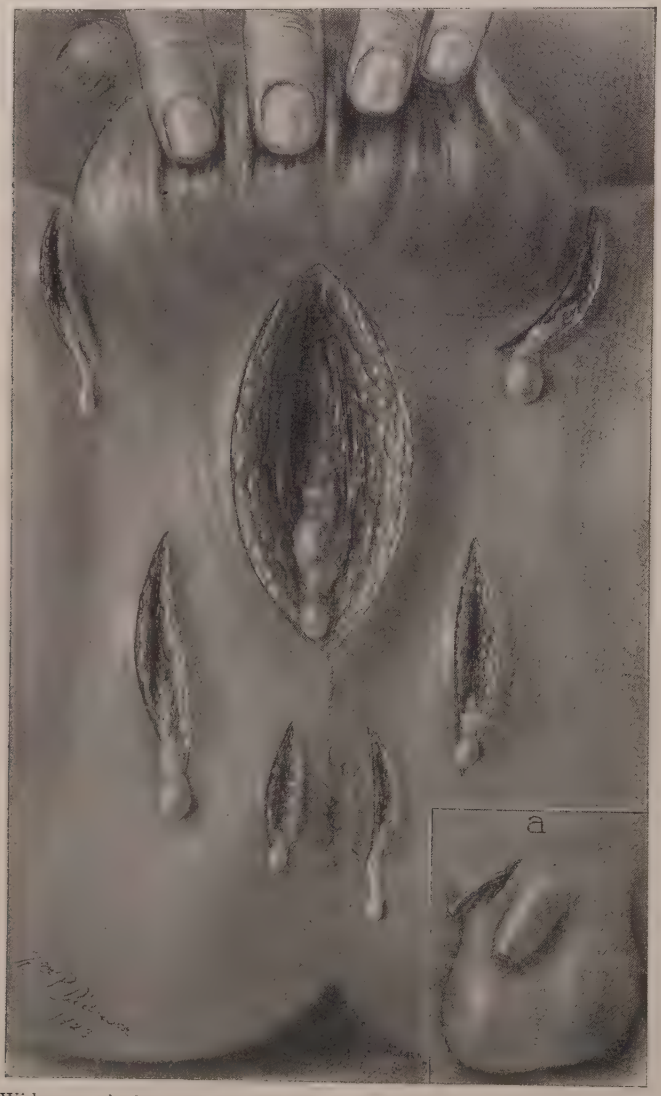


FIG. 933.—Wide-spread abscess of perineal, rectal, and scrotal regions requiring multiple incision and drainage. Treated unsuccessfully by Christian Science for ten days before admission. *a*, Counter-incision in groin. B. U. I. 11,979.

taneously, and their subsequent cure may be facilitated by intra-urethral treatment or urethroscopic operations (local injections, dilation of orifice, cure of stricture by dilations, etc.). Where the abscess involves the pendulous urethra it is preferable to have it rupture into the urethra than externally. Permanent urinary fistulæ are quite apt to follow external rupture of peri-urethral abscess of the penile portion. Where there is little tendency to evacuate into the urethra, and external evacuation is apparently necessary, it has been our plan to make an incision in the skin not directly upon the abscess, but at a point remote from it, and then by elevating the skin by blunt dissection to finally puncture the abscess from a distance and thus evacuate its contents through a long fistulous tract. By this procedure urinary fistula is avoided. Small peri-urethral abscesses are sometimes due to para-urethral ducts, the orifice of which can sometimes be located near the meatus. They may be injected by means of a hypodermic needle, but occasionally require wide incision and drainage, which can be carried out without danger of urinary fistulæ. Abscess of the perineal or scrotal urethra should be opened widely (Fig. 933). At the same time a careful search for stricture or other causes of the abscess should be made and the defects corrected. In the region of the bulb and triangular ligament infections of Cowper's glands are frequently responsible for localized abscesses. This subject has been very fully discussed by Motz and Bartrina.[1]

In some cases these abscesses are encapsulated and can be completely excised, in others simple incision and curettage should be done. Peri-urethral abscesses back of the triangular ligament require wide incision and thorough investigation to discover the extent of their invasion. Not infrequently the ischiorectal fossa is extensively infiltrated and occasionally the infection travels up and around the prostate into the prevesical region. In such cases unless adequate drainage can be obtained posteriorly a suprapubic prevesical incision or incisions may be desirable to obtain adequate drainage and facilities for antiseptic treatment. Periprostatic and perivesicular abscesses are described elsewhere.

OPERATIONS FOR RUPTURE OF THE URETHRA

As stated in Chapter X, the lesions found in rupture of the urethra vary from a slight laceration to complete section of the urethra, and may even be complicated with extensive fracture of the pelvis and other bones, with urinary and fecal extravasation. Where there is only very slight laceration of the urethra, the patient may be able to void without difficulty, and urine may not extravasate. Such cases need, as a rule, no operative interference unless infection occurs.

Where the rupture is more extensive and especially if associated with marked hematoma or extravasation, very early operation is desirable and it is usually wise to expose the lacerated area through a perineal incision and by careful suture, after removal of badly lacerated tissues, to anastomose the ruptured parts and restore the integrity of the canal around a catheter, which may be left in place for a week or more. In such cases at least two layers of catgut sutures are desirable, but it is usually unwise to close the skin, which is left open for drainage. Such ruptures usually occur in the bulbous urethra, 1 cm. or more in front of the triangular ligament.

Where the rupture is complete and the ends of the urethra separated, a very

[1] Annales des Maladies des Organes Génito-Urinaires, 1903, xxi, 1601–1630.

careful anastomosis of the cut ends should be carried out unless the destruction of tissue is too great, in which case it may be possible, by mobilization of the adjacent ends of healthy urethra, to draw the cut edges together by appropriate sutures. Good results may be obtained, even when it is impossible to suture more than a part of the circumference, if a large catheter is left in place.

When associated with fracture of the pelvis, not infrequently the rupture is in or above the triangular ligament, in which case the incision is not a median perineal, but preferably an inverted V, the exposure being similar to that for the prostate. After careful division of the central tendon and the recto-urethralis muscle, the membranous urethra is reached, and the sound, which has been previously introduced, found perhaps free in the traumatic wound. In one of our cases, a young man, who had been mashed between two freight cars, we found a complete rupture of the membranous urethra at its junction with the prostate; a large hematoma was present and the prostate had been carried upward for a distance of at least 3 inches from the triangular ligament. After evacuation of the clot it was possible to draw the prostate down to its proper position. The bladder was greatly distended, there being no escape of urine through the prostatic urethra. A catheter was passed, the bladder evacuated, and anastomosis performed with interrupted sutures of catgut, reinforced by external sutures. The catheter was left in place for a few days, the wound healed rapidly, and no stricture developed. The patient's only complaint afterward was complete loss of sexual powers.

In case of extensive extravasation it may be necessary to supply drainage prevesically and laterally, even as high up as the perirenal region, depending entirely on the extent of the extravasation.

OPERATIONS FOR TUMORS OF THE URETHRA

Cancer of the deeper urethra (bulbous or membranous) is usually so extensive and has already involved so many of the adjacent structures that radical operation is out of the question. Radium or *x*-ray may be tried, but has met with little success in our hands. If obstruction to urination supervenes, suprapubic drainage may be desirable to give relief. If any operation on the growth itself is attempted, it must be most radical. Partial operations, like those sometimes used in carcinoma of the prostate, are not permissible, as the different character of the growth makes wound implantation almost inevitable. Cancer of the pendulous urethra is treated by radical operation, as in cancer of the penis, *q. v.*

OPERATIONS FOR HYPOSPADIAS

In 1874 S. Duplay[1] presented the first of a series of important papers on the cure of hypospadias. After describing the method of Moutet Angier, which was exactly the same as the method of Thiersch for epispadias, he presented his own method for the treatment of hypospadias, which the accompanying illustrations portray.

Six years later Duplay[2] he reported the results which he had obtained by the methods previously described and stated that time had shown that the best method of treatment was: First séance, correction of deformity of penis and creation of a new urethral canal in the glans; second séance, creation of a new canal from the

[1] Archives de Médecine, cxxxiii, 513–657.
[2] Ibid., cxlv, 257–274.

glans to the hypospadiac opening, by his plastic technic; third séance, connection of the two parts of the canal by closure of the posterior opening at the site of the old hypospadiac meatus. He reported certain modifications, the principle of which was the use of fine silver wire sutures passed through tubes of Galli, by means of which broad surfaces of skin were drawn together, as shown in Fig. 944.

As to his results, he states that at that time there were 5 cases completely cured—1 of penoscrotal and 4 of perineoscrotal hypospadias. Micturition and coitus were apparently normal. Since Duplay various new operations and modifications of technic have been published.

C. H. Mayo in 1901[1] presented the following method for the cure of glandular and anterior penile hypospadias:

> The principle of a urethra made of prepuce was devised by Van Hook. The prepuce is extended as for circumcision and two incisions are made, about 1 inch apart, extending from its free border to its attachment at the penile cervix; the prepuce is unfolded, forming a loop of thin skin about 2½ inches in length. Should this not be considered sufficient to reach from its attachment to the hypospadiac opening, the two incisions are extended back along the dorsum of the penis until sufficient tissue is obtained, when the two incisions are connected by a transverse one. The pediculated flap of prepuce is constructed into a tube by means of catgut; the penis is tunneled by means of a narrow bistoury or trocar, through the glans, along the penis to a point beneath the hypospadiac opening, where it is made to emerge by the side of the urethra. The tube of prepuce is drawn through the tunnel and sutured where it enters the glans and also where it emerges.

The *problem* is, as a rule, to correct deformities and complete the urethra. The deformities, which are varied, have already been described, but will be again referred to when the different types of operations are given. The operation for hypospadias is complicated in various ways. If it is attempted too young, the child is so difficult to handle that both pre- and postoperative treatment are extremely difficult and unsatisfactory. It is therefore advisable to carry out the operation on infants only to correct severe deformities and prepare for later plastic procedures to form a new urethra. The operation should generally be a simple plastic according to Heinecke-Mikulicz principle to eliminate congenital chordee and to allow the penis to grow straight and unrestricted. Abnormalities of the scrotum and scrotal contents should generally be left to a later age as the vas is so minute in infancy as to make its detection difficult.

The only plastic operation to normalize the urethra which can be safely done in infancy is the Beck operation, which is applicable only to slight glandular or anterior penile hypospadias.

The time of election is after the age of seven and before puberty. At this time the child is easier to handle—submits with less resistance to postoperative treatment, dilatations, etc., than in infancy, but more important still is the absence of erections which are likely to break down the wound and nullify the operator's work. If the operative efforts to cure the hypospadias are likely to extend over several years, it is well to begin early enough to finish before puberty. Unfortunately, most patients seek treatment after puberty and not infrequently after maturity.

Glandular hypospadias (Figs. 934, 935) is that form in which the urethra is absent or imperfect in the glandular portion. In the simplest form the meatus

[1] Journal American Medical Association, 1901, xxxvi, 1157–1162.

is found on the under surface of the penis just back of the glans. In front of this the urethra is absent and may be represented by a furrow or fairly deep ditch in the under surface of the glans or the furrow may be absent and the glans convex. In other cases the glandular urethra may be present but imperfect and represented either by a dimple in the position of the normal meatus with a septum behind it, or, again, the dimple may be absent and the posterior part of the glans occupied by a blind pouch which opens at the hypospadiac opening. These dif-

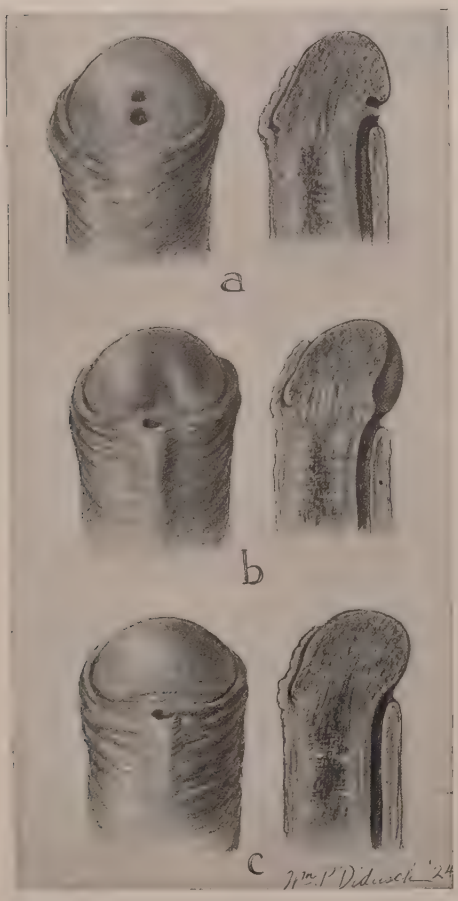


FIG. 934.—Glandular hypospadias: *a*, Type with pouch in front of congenital meatus. *b*, Type with furrow in glans in front of congenital meatus. *c*, Type without furrow, glans being round in front of congenital meatus.

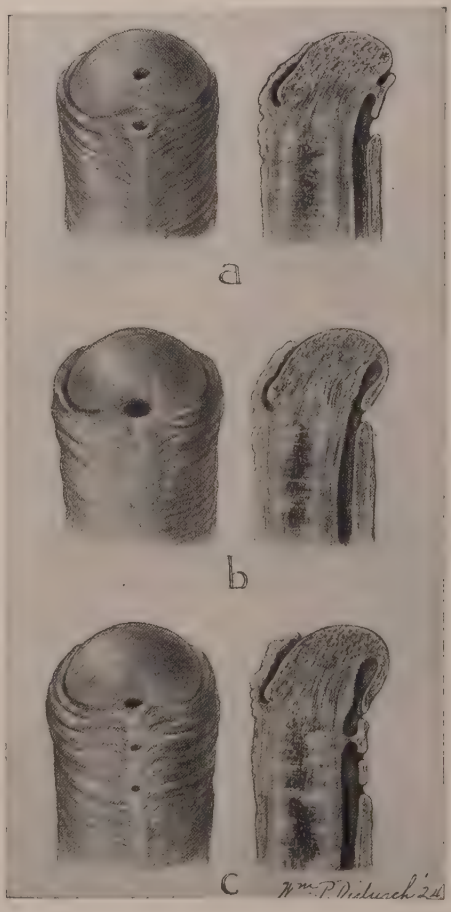


FIG. 935.—Hypospadias: *a*, Glandular type with pockets in front and behind septum. *b*, With pocket in front of congenital meatus. *c*, With multiple congenital openings.

ferent types are shown in the accompanying figures. Other slight variations may occur, such as multiple openings, with single or multiple septa, etc.

Before carrying out any important plastic operation upon the penis, means must be adopted to prevent the postoperative soiling of the wound with urine. Where the urinary meatus is situated far back (perineal or scrotal), operations upon the anterior part of the penis may be done without regard to the urine, which may either be voided naturally through the congenital meatus or pass out through a catheter fastened in the urethra. It is well established that a drainage

catheter should not be brought out through the new operative wound, but that perineal drainage should be employed, even in the first straightening operation for glandular and penile hypospadias.

Perineal Section for Drainage.—This is carried out as follows: With the patient on his back, the legs elevated by the side bars and knee crutches, a dorsal incision of the urinary meatus is made to enlarge the orifice sufficiently to admit a No. 20 F. sound. The special instrument which we have devised for urethrotomy (Figs. 912, 914, 915), or a sound is then inserted until the beak is in the perineal urethra. Pressure is made upon the instrument so that the convex portion of the beak is visible as it presses outward the structures covering the median portion of the bulbous urethra. The handle operating the obturator is then turned, thus forc-

Fig. 936.—Showing preliminary perineal drainage previous to plastic operation. Bulbous urethra in front of perineal tube closed by encircling suture tied around rubber tube.

Fig. 937.—Perineal urethrostomy for permanent drainage without tube.

ing out the lower end which carries the "mouse teeth" which impale the urethra, hold it up, and prevent its retraction when incised. A small incision about $\frac{1}{2}$ inch (or 2 cm. long) is then made quickly through skin, subcutaneous and urethral tissues upon the central groove of the obturator. The edges of the mucous membrane, which are found held up on each side upon the points of the obturator, are picked up with Allis clamps. The obturator is then withdrawn into the sheath, by turning the handle at the outer end, and the entire instrument pulled out of the urethra. A fairly large catheter (varying, according to the age of the patient, from 16 to 20 F.) is then inserted into the bladder, adjusted to a proper depth for permanent drainage and fastened to one side of the wound by a transfixion suture of heavy silk. For several years past we have followed the procedure of inserting a transfixion stitch of heavy silk through the perineal tissues around the urethra

(Fig. 936) in front of the urethrotomy wound. The object of this is to close the urethra and prevent urine escaping anteriorly, should the tube come out, or urine be evacuated from the bladder around it, as not infrequently occurs. This circumurethral suture of silk is then tied around a minute pad of gauze, or rubber tube, but only tightly enough to close the urethra and not too greatly constrict it.

Perineal Urethrostomy.—In order to avoid a retention catheter and the complication of urethritis and cystitis, a permanent urethral opening may be made in the perineum. In order to accomplish this, the incision is made sufficiently long in both skin and urethra so that the two may be sewed together, thus forming a mucocutaneous fistula which is fairly long, and out of which all of the urine will flow freely (Fig. 937). In children the perineal tissues are so thin that this procedure is not difficult. In fat adults perineal urethrostomy is much more difficult and requires such a long incision as to make it distinctly objectionable. No catheter is inserted into the bladder after this operation and the urethrostomy is preserved until all operations necessary to repair the hypospadias have been carried out, even though several years may elapse. Until recently almost all hypospadias cases which have been drained through a perineal retention catheter have become infected.

Continuous Antiseptic Bladder Drainage.—Recently we have employed the method which we use for decompression drainage of the bladder preparatory to prostatectomy, with splendid result. The Shaw-Young apparatus (see Figs. 46, 47) makes it possible to supply good drainage and at the same time keep the bladder bathed in an antiseptic solution which prevents infection. This method seems distinctly preferable to urethrostomy as the urethra may be allowed to heal between successive operative attacks upon the penis to cure the hypospadias.

Perineal drainage having been provided, the patient is placed in position for operation upon the penis. When using our table this is accomplished by simply lowering the leg rests. The penis is then carefully cleaned again and for this purpose we employ 2 per cent. solution of mercurochrome in alcohol-acetone, which has the advantage that it does not irritate the delicate tissues of the penis and scrotum. The urethra is again injected with some mild antiseptic (0.5 per cent. meroxyl). The towels are properly draped and the operator takes a seat between the knees of the patient, facing the field of operation on the under surface of the penis. Two transfixion sutures with straight intestinal needles are placed through the two sides of the glans and used for traction while the operation is planned and executed. A pad of gauze folded to form a cushion may well be placed beneath the dorsum of the penis to support it. The operator should bear in mind that all flaps retract very greatly. Even when abundant allowance is made for this, one is often greatly astonished to find how little skin is left to form a urethra when the closure is begun.

Plastic Operations for Glandular Hypospadias.—This form of hypospadias is generally not accompanied by much retraction of the end of the penis, which, in erection, is straight. There may be, however, a distinct congenital retraction of the glans, which is pronounced on erection, and may so pull back the end of the penis and shorten the inferior surface as to cause distinct curvature of the penis and either difficulty of entrance or imperfect coitus. In such cases, the operative treatment of glandular hypospadias must be preceded by an operation to correct the congenital retraction or chordee (Fig. 938). After correcting the

congenital chordee it is well to wait six months or more before carrying out the next step—closure of the defect in the urethra.

Method A.—The operative treatment for the simple non-retracting type, in which the urethra in the glans is represented by a gutter which leads back to the congenital meatus behind the glans, is usually best carried out by the technic of Duplay. The incision is made deep into the substance of the glans on each side

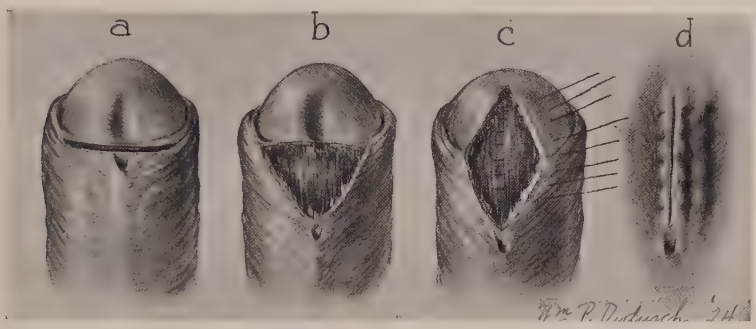


FIG. 938.—Hypospadias, anterior penile type; operation to cure curvature (preliminary): *a*, Transverse incision in front of meatus. *b*, Fibrous restricting bands have been excised. *c*, Deeper fascia brought together with mattress-sutures brought out through skin. *d*, Skin closed with vertical mattress.

of the furrow, and parallel to it, leaving enough mucous membrane to form a urethra, the edges to be turned in and sutured around a No. 18 F. catheter. This requires approximately 2 cm. of skin. The incision is then carried backward so as to encompass the urinary meatus, thus forming a U with the branches anterior, as shown in Fig. 939, *a*. The dissection around the meatus must be made very carefully so as not to open the urethra. The adjacent skin is elevated and the margin of the meatus carefully pared with scissors so as to give a good surface to be turned

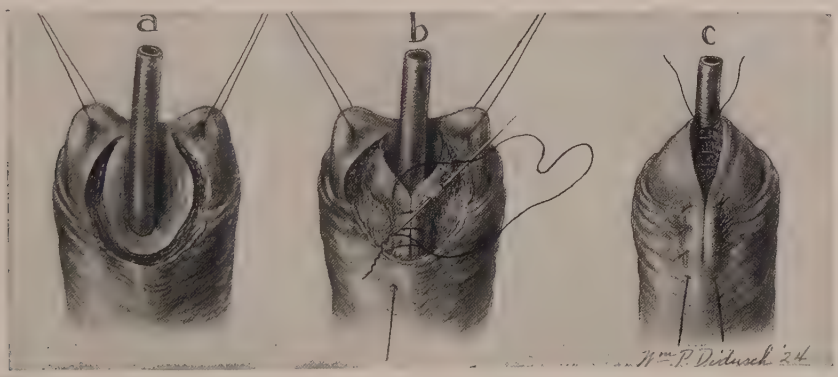


FIG. 939.—Hypospadias, glandular and anterior penile. Plastic operation to close. Removable continuous silk sutures are used in this case.

in when the edges are brought together for suturing around a No. 18 F. rubber catheter (or smaller if necessary). The approximation of the inner surface to form a new urethra may be accomplished in various ways and it is difficult to say which is the best. The employment of catgut as a suture material has the objection that it swells, appears to be prone to infection, absorbs quickly if not chromicized, and lasts too long if chromicized. Nevertheless, it may be preferable to buried silk which often suppurates and requires removal. A continuous Cushing mattress-

suture may be employed with exit through the skin posteriorly and at the meatus anteriorly; this may be withdrawn after ten to fourteen days by simple traction. This technic is shown in Fig. 939, *b*. Another continuous silk stitch reinforcing the peri-urethral tissues may be inserted in the same way. The skin may then be closed by simple mattress-sutures of silk. The mattress-suture may be placed vertically instead of horizontally, as shown in Fig. 939, *c*. We believe this is good, as it cuts off much less blood-supply and brings broader surfaces into apposition. The nearly finished operation by this technic is shown in Fig. 939, *c*.

Method B.—The line of incision and the preparatory dissection are the same, but the tissues to form the new urethra are drawn together with mattress-sutures of silk which are so placed as to turn in the edges and are brought out through the skin on one side to be tied around a rubber tube, or silver wire, as shown in Fig. 940, *b*. This method has the advantage that it brings broad surfaces together and that the knots are tied on the outside. No subcutaneous reinforcing sutures are

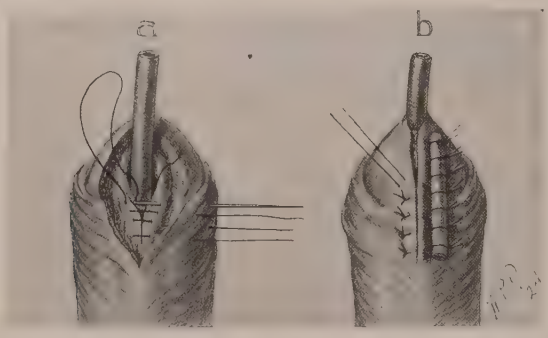


Fig. 940.—Glandular hypospadias. Closure with removable mattress-sutures of silk. B. U. I. 10,082.

necessary. Skin may be closed by mattress-sutures as described in Method A, or by other methods. In the following case Method B was employed successfully:

B. U. I. 10,082, H. S., age eight, admitted July 26, 1922 with glandular hypospadias. The penis was normal size, the foreskin hooded, the frenum absent, glandular hypospadias present, urinary meatus about $1\frac{5}{10}$ cm. behind the normal opening. There was a slit-like urethral opening in the glans penis which was only patent for a short distance, behind which there was a septum. Scrotal contents negative.

July 27, 1922: Operation, external urethrotomy, insertion of No. 14 soft-rubber catheter into bladder; held in place with silk ligatures. Sound again passed into urethra and a needle carrying a heavy silk suture introduced so as to entirely encompass it. A rubber tube was inserted into the tie to prevent cutting of the skin. The external meatus was very small and situated about $\frac{1}{2}$ inch posterior to the glans. A rubber catheter of small caliber was passed into the urethra and a U-shaped incision made around the anterior meatus and carried on deeply into the substance of the glans. The surrounding skin was dissected free and the urethra closed by means of three interrupted mattress-sutures of silk which turned the skin edges inward upon the catheter. These sutures were brought out through the second skin flap on the left side and tied around a small piece of rubber tubing. There was no difficulty in securing close approximation of the new urethra, with these three mattress-sutures. The outer flaps of skin were then approximated by means of three mattress-sutures of silk which were likewise tied over a piece of small tubing to prevent cutting. The catheter within the urethra was then withdrawn, dry dressings applied, and the patient returned to the ward.

July 29th: Wound looks healthy, sutures removed.

August 8th: Thirteenth day, perineal tube removed. Penis well healed.

August 10th: Patient voids mostly through the urethra. Result excellent.

August 14th: Patient discharged. Urethral plastic perfect, no cicatricial chordee. Urinary stream of good size and only small amount escapes through the perineum. Urine sterile.

September 6th: It is now two months since operation. Perineal wound healed. Hypospadias completely cured. Urine passes through meatus in glans, no fistula. Urination normal.

Where no gutter is present in the glans and particularly where there is a blind meatus and pouch in the normal position, various methods may be used satisfactorily to produce a glandular urethra.

Method C: The Von Hacker or Beck Operation.—This procedure, as shown in Fig. 941, consists briefly in isolation of the terminal portion of the urethra and bringing it down to form a urethra for the glans. A button of skin surrounding the meatus is carefully preserved (Fig. 941, *a*), and is an important feature of the operation. By means of a slender bistoury a tunnel is made by puncturing the glans penis (Fig. 941, *b*), and through this tunnel the button-shaped end of the meatus is drawn and sutured to the end of the penis, as shown in Fig. 941, *c*. Unless this terminal enlargement of skin is preserved, stricture is apt to follow at the

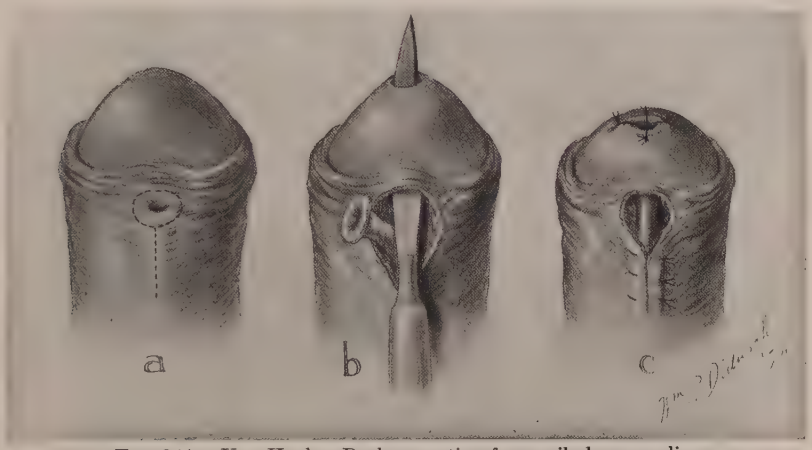


Fig. 941.—Von Hacker-Beck operation for penile hypospadias.

meatus. This operation has been used by many operators for both glandular and anterior penile hypospadias. Enthusiastic support has been given by various writers to this procedure which is described by some as the operation of choice for all forms of glandular hypospadias. It is claimed by the author and some of his followers that no retraction of the penis, chordee, or shortening occurs. We have never employed this procedure, because in practically all of our cases we have found on examination that if we attempted the Beck operation, the penis, which was already slightly or markedly curved, would be more so as result of the operation. We have therefore preferred to utilize the Duplay method as above described (A and B) or some other form of plastic to produce a glandular urethra.

Method D: Urethra Made of Skin Transplant.—(*a*) *Russell's Operation.*—In 1900 Russell[1] described a method by which the foreskin was employed to form a glandular urethra as follows: first operation: the chordee is corrected by a transverse incision through the skin and subcutaneous tissues which bind down the penis. The penis is then straightened by cutting all constricting bands. The

[1] British Medical Journal, 1900, ii, 1432–1435.

glans is then tunneled with a slender knife. A flap is prepared from the foreskin. An incision is carried three-fourths around the penis through the foreskin just back of the coronal sulcus. A second incision is then made through the foreskin at a distance of about 2 cm. from the first, thus forming a cuff around the penis. This is detached except at the two ends near the urethral opening, slipped over the end of the penis, turned inside out, and then drawn through the tunnel in the glans penis with the skin edges approximated. The deeper ends are left attached to the penis below the glans on each side. The flaps, as they emerge from the glans penis above, are sutured to the glans. The congenital meatus, with its

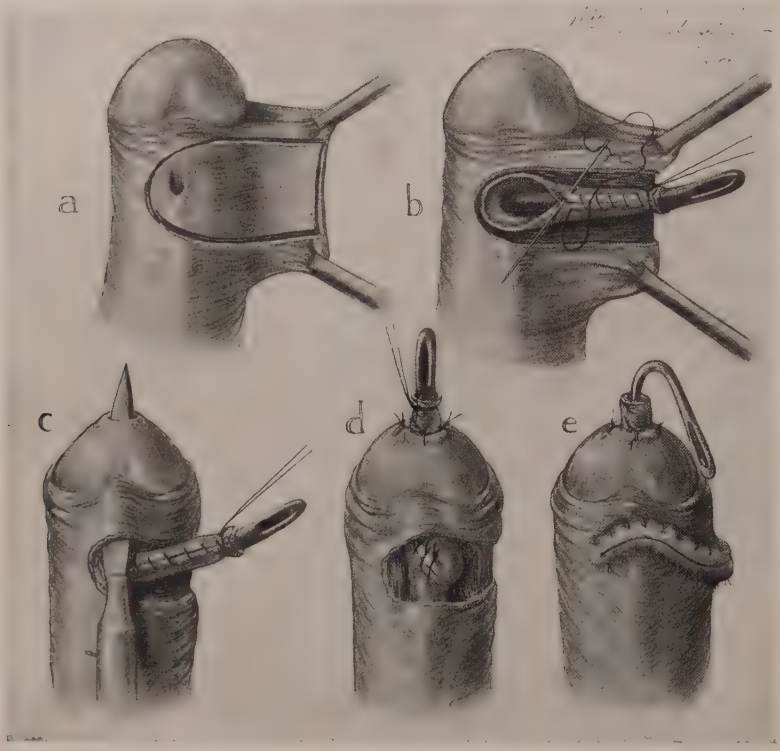


FIG. 942.—Hypospadias, glandular. Formation of new urethra from foreskin, method of Young: *b*, Catgut sutures employed to form new urethra. *e*, Silver probe inserted in rubber tube before removing it, and kept in place for ten days. B. U. I. 10,084.

edges freshened, is anastomosed with the skin flaps. The skin is then closed over the graft.

(*b*) *Method of Mayo.*[1]—Here the tube of skin is made from the prepuce along the dorsum and then drawn through the tunnel in the glans from below upward and sutured at its upper end to the urinary meatus.

We have employed a preputial skin flap to form a glandular urethra as follows:

(*c*) *Young's Method.*—An incision is made around three-fourths of the meatus and then continued by two straight lines around the penis so as to utilize an area of skin which is largely taken from the prepuce and measures about 2 cm. wide, and 3 to 4 cm. long (Fig. 942, *a*). This is sutured around a small rubber

[1] Journal of the American Medical Association, 1901, xxxvi, 1157–1162.

catheter in the penile urethra, the edges being turned in by continuous Cushing mattress-suture, preferably of catgut (Fig. 942, *b*). In preparing the tunnel, an incision has been made transversely immediately in front of the urinary meatus. In this, a narrow scalpel is inserted and slowly pushed forward beneath the skin and through the tissues of the glans until the point emerges at the proper place near the tip (Fig. 942, *c*). This incision should be enlarged in the glans with a scalpel, both transversely and anteriorly. A clamp is then introduced from the glans backward, the catheter is grasped and the tube of skin graft drawn through the tunnel until it emerges well beyond the orifice (Fig. 942, *d*). At the base, the flap is rotated so that the edges of the graft are approximated by sutures which may be either buried catgut or preferably mattress-sutures of silk which emerge from the skin to be tied later. The wound and the newly made urethra are then covered by skin, which is brought up as a flap from the side of the penis and closed in the form of an inverted V, thus avoiding a longitudinal median line incision,

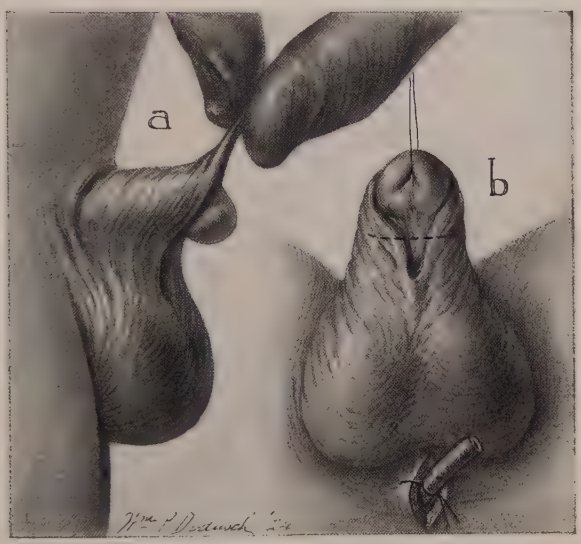


FIG. 943.—Hypospadias, penile: *a*, Congenital chordee and hooded foreskin; *b*, Dotted line shows transverse incision to relieve chordee and lengthen penis.

which is always bad and likely to lead to sinuses. A silver probe (Fig. 942, *e*) is passed down the catheter which is then withdrawn, leaving the probe in place to hold the new urethra in line with the old. The probe projects from the perineal wound and is bent up at both ends to keep it from slipping out. The skin is closed transversely (Fig. 942, *e*).

Glandular hypospadias associated with congenital chordee, or retraction of the glans and curvature of the penis on erection, necessitates a straightening operation before the urethral plastic is performed. This straightening is carried out by means of a transverse incision which divides the deeper structures, liberates the penis so that it may be drawn outward, the wound then being closed in a longitudinal direction according to the Heinecke principle (Fig. 938). This operation straightens the penis and allows perfect erections, but it invariably transforms hypospadias from the glandular to the penile type and the operation therefore belongs to the category of penile hypospadias.

Penile Hypospadias; Anterior Half.—This form of hypospadias comprises those varieties in which the opening is well back of the glans and anywhere along the under surface of the penis (Fig. 943) to a point half-way to the penoscrotal

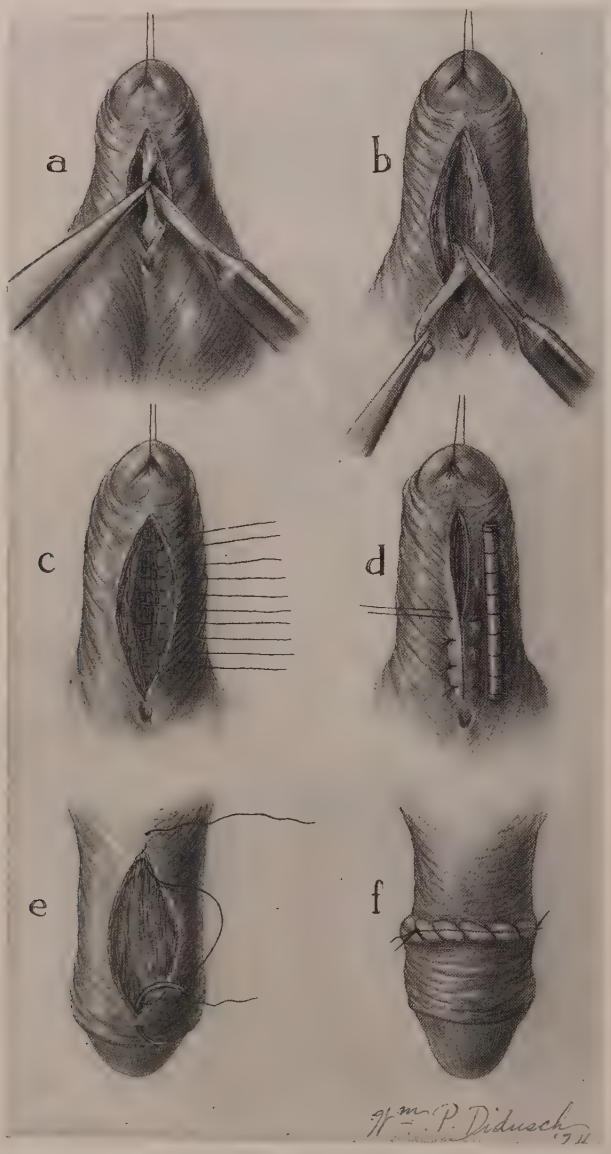


Fig. 944.—Hypospadias, penile, congenital chordee. Later stages of operation to relieve chordee and lengthen penis: *a*, Transverse incision has been drawn out until it appears longitudinal. Restricting fibrous band is dissected free from corpora. *b*, Dissection carried between corpora so as to excise part of septum and completely free the penis, thus greatly lengthening it. *c*, The deep fascia (corporal) is approximated with mattress-sutures of silk which are brought out through skin (special triple mattress). *d*, Deep triple mattress-sutures are tied around tube, avoiding tension. Skin approximated with a vertical mattress. *e*, Plastic on dorsum, longitudinal incision and transverse closure (*f*).

juncture. The defect here consists ordinarily of a congenital chordee and an absence of urethra, generally for about 3 to 4 cm. The operation should be done in two stages—in the first of which a perineal drainage is performed and *the penis*

straightened by the Heinecke principle of transverse incision and longitudinal closure. This incision is made at the point of greatest curvature and varies in length according to the age of the patient, the size of the penis, and the extent of the curvature.

The skin, subcutaneous tissues, and fascia of the penis are divided (Fig. 943, *b*) until the fascia propria of the corpora cavernosa is reached. The corpora should be respected in order to avoid unnecessary hemorrhage and injury of the erectile tissues, but the fibrous tissue and fascia between the corpora should be carefully dissected out above and below (Fig. 944, *a*, *b*). After this is done and the corpora liberated, the penis may be drawn out to a much greater length than before and completely straightened. The two edges of the wound are pushed further and further apart as this dissection proceeds. The congenital urinary meatus, as a result, will be found to be several centimeters farther from the glans when the operation is completed. The wound is approximated longitudinally by deep sutures of fine silk through the deep fascia on each side and brought out through the skin (Fig. 944, *c*). This facilitates the approximation of the skin in the second line of sutures with vertical mattress-sutures of silk (Fig. 944, *d*).

When, by the method just described, a diamond-shaped area is closed longitudinally, considerable tension will usually be found in the middle of the wound. This is completely relieved by means of an opposite plastic upon the dorsum of the penis, viz., longitudinal incision through skin and fascia (Fig. 944, *e*) with transverse closure (Fig. 944, *f*). We have employed this for many years and have found it of great value. We found it well to have the penis fastened to the skin of the abdomen, during the healing process, in order to insure as great lengthening as possible. A silver wire is placed in the skin above the pubis and a silk suture through the glans. A rubber elastic joins the two for continuous traction. At present we prefer wet dressings of a weak antiseptic (1 : 1000 meroxyl), upon which is placed an ice-pack to prevent erections in case the patient is past puberty. The patient is also given large doses of bromides for at least ten days.

The second operation, to form a new urethra and complete the cure, is carried out at a later date as shown in the following case:

Plastic to cure anterior penile hypospadias. Tubular graft of foreskin transplanted to form new urethra.

B. U. I. 10,084, J. L. R., age nine, admitted November 5, 1921. Patient had penile hypospadias. Examination showed that the urinary meatus was 1.5 cm. back of the glans; moderate congenital chordee just behind glans penis; foreskin very redundant.

April 3, 1922: Operation, Young; ether anesthesia. First stage of operation for hypospadias. (1) Perineal urethrotomy and insertion of rubber catheter for drainage. (2) Transverse incision on under surface of penis just back of glans, excision of fibrous tissue, completely freeing the penis which could then be straightened perfectly. The wound was closed by deep mattress-sutures which caught the deep fascia on each side and which emerged through the skin on one side. When drawn tight, the corpora were approximated and the skin along with them. The skin was then approximated with metal clips. No buried sutures used. There was some tension present in the skin, and to relieve this, and also to draw the glans penis upward along the dorsum, a plastic exactly opposite of that on the under surface was carried out on the dorsum of the penis, viz, a longitudinal incision through the skin and fascia and a transverse closure. Deep mattress-sutures of silk were employed for the first line, tied outside of skin. Skin edges approximated with metal clips externally. The penis was fastened to the abdomen, as previously described.

April 20, 1922: It is now seventeen days since operation. The result is excellent. Swelling of foreskin, which was considerable, has almost disappeared. Wound has healed well. Perineal

tube removed on the fourteenth day and urine is now escaping partly through the meatus. The correction of the curvature is excellent and the result apparently good.

August 1, 1924: Patient returns for a *second operation.* The penis is now straight, meatus is situated about ½ inch behind the glans, which is round and contains no furrow. The first operation has succeeded in correcting the deformity completely. Patient is now twelve years old, and the genitalia are well developed.

August 1, 1924: Operation, Young; gas and ether. (1) Perineal section for drainage. (2) Plastic to form penile and glandular urethra. Owing to the fact that there was no furrow present in the glans, it was thought best to do a tunneling operation and to make a new urethra out of the foreskin. This was carried out by a new procedure, as shown in Fig. 942. A three-fourth circular incision was made around the meatus and the skin dissected up. This incision was carried outward toward the left, largely in the redundant foreskin which was drawn up in that direction by clamps. The area of skin measured about 2 cm. in width and 4 cm. in length and consisted of skin and subcutaneous tissue, about 3 mm. thick. This transplant was freed from the deeper structures except at the pedicle near the congenital meatus, where by blunt dissection it was drawn out without dividing the tissues (thus preserving a good blood-supply). A No. 14 catheter was placed in the urinary meatus and passed for several centimeters down the urethra. The skin flap was then sewed around the catheter with the epidermis inside and the edges turned in by a continuous mattress catgut suture. A tunnel was then made in the glans with a small scalpel, beginning at the anterior edge of the incision around the urethral meatus and burrowing beneath the skin until the proper point for the meatus was reached near the tip of the glans. This was enlarged laterally and vertically in front, an artery forcep passed down it, and the catheter drawn out through the tunnel, accompanied by the tube of skin which surrounded and was ligated to it at the outer end. There remained a hiatus on the left side and this was closed by suturing the edge of the skin to the tissues around the meatus, thus closing the defect. The skin which was drawn out of the meatus, was fastened by means of two stitches of catgut. There now remained an irregular transverse wound which extended far on the left side into the foreskin which was quite redundant. A longitudinal incision was then made along the right side of the penis and the skin drawn over so as to cover the graft and the line of sutures. This was fastened by a transverse line of mattress-sutures of silk back of glans penis. The catheter in the transplant was then removed and a fine silver probe inserted through the newly made urethra and out through the perineal wound. The ends were bent so as to prevent its slipping out. The penis was held up against the abdomen by means of sutures with intervening elastic.

Convalescence: The patient made an uneventful convalescence, cold antiseptic compresses (1 : 1000 meroxyl) with ice-bag being employed. The patient had no erections and the wound healed without suppuration. Stitches were removed at end of ninth day and silver probe on tenth day. There was absolutely no suppuration around probe in the urethra. During this time, by means of an irrigating decompression apparatus, the bladder was kept bathed in antiseptic fluid through perineal tube and the urine remained sterile. The catheter was removed on the fourteenth day and the urethral ligature removed at the same time. Filiforms were then passed with ease through the meatus and out through the perineum and a No. 16 F. follower passed without difficulty through new urethra and on into the bladder. No stricture present.

Grafts of other types have been employed in our clinic, viz., *Thiersch grafts from the thigh and whole skin grafts from the thigh or scrotum.* The *saphenous vein* has also been used. Of these, we greatly prefer whole skin-grafts made from the prepuce, with pedicle, as above described.

There are other methods of closing penile and glandular hypospadiac defects, but we have had little experience with them. Thiersch's overlapping flaps (Fig. 946) are perhaps a slight improvement over Duplay's (Fig. 945). Skin flaps from adjacent structures have been used with varying success in our cases.

Penile Hypospadias; Posterior Half.—The reason for this subdivision is that when the meatus becomes more distant from the glans, the operative problem to form a new urethra changes and the methods employed for the anterior half of the penile urethra are often entirely inapplicable.

The following methods have been found satisfactory: (*a*) *The method of Duplay* has been employed in the majority of cases in our clinic, with the following technic. The penis, having been straightened by a previous Heinecke procedure,

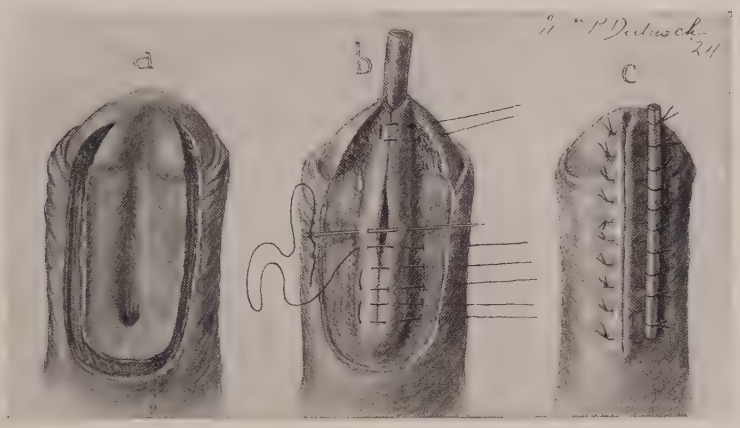


FIG. 945.—Glandular and penile hypospadias. Closure by method of Duplay, but using removable mattress silk sutures: *a*, Wide skin incision; *b*, formation of tube; *c*, closure, ligatures tied around a rubber tube.

subsequent operation is undertaken to form a new urethra. In most of our cases there was a furrow in the glans and the incisions were made, beginning at the glans on each side and extending back (about 1 cm. distant on each side from

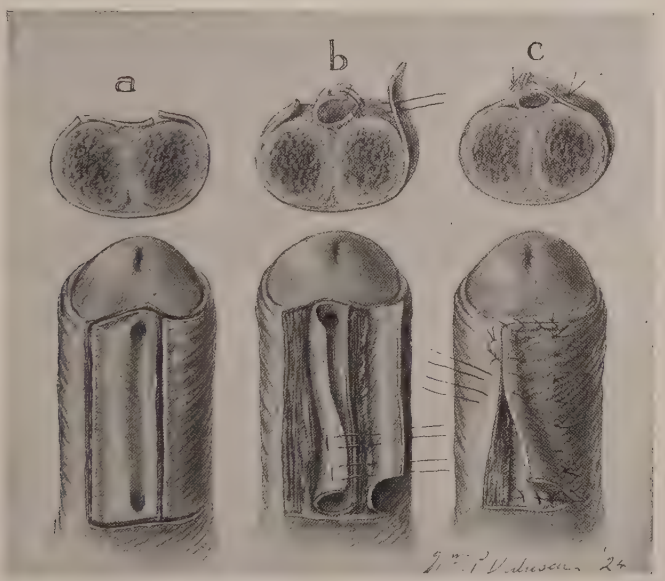


FIG. 946.—Hypospadias. Second operation, after formation of glandular urethra. Overlapping skin flaps after method of Thiersch. Removable silk mattress-sutures used. *a*, Skin incisions; *b*, formation of tube; *c*, closure.

the midline) until the urethral meatus was reached, where the incisions were joined in a curved line around the meatus (Fig. 945, *a*). This is a similar procedure to that employed for glandular hypospadias. The external edges were dissected up and the internal edges also elevated for a short distance, care being

taken to leave them sufficiently thick and not to injure the blood-supply. The new urethra was made from the glans to the meatus by turning in the skin edges over a small catheter (Fig. 945, *b*).

Various methods and material have been employed, with varying success, for sutures. Probably the best results have been obtained with silk mattress-sutures brought out through the outer skin flap and inverting the inner skin flaps, approximation of the outer flaps being made with mattress-sutures of silk (Fig. 945, *c*). The glans is closed in the same way. Tension at the root of the penis was generally found present after approximating the flaps and was relieved by a Heinecke operation on the dorsum (longitudinal incision and transverse closure).

The study of results shows that in almost all instances one or more small breaks occur in the line of suture and fistulæ may form. These may be due to tension, infection, imperfect circulation, and uncontrollable erections. Occasionally the glandular portion has completely broken down. In other cases the glans has remained intact and one or two small fistulæ have formed, generally immediately back of the glans and at the point of closure over the old meatus. Subsequent operations were required and sometimes repeated two to three times before every fistula was healed. Occasionally pinpoint openings, which caused little or no inconvenience, were extremely difficult to close and sometimes remained regardless of all efforts.

During the convalescence the use of filiforms and followers, for dilatation of the newly made urethra and at the point of anastomosis, is always carried out. Excellent immediate results were occasionally turned into failures where refractory young patients did not return for dilatations. In several cases a second operation had to be carried out on account of stricture. Occasionally filiforms could only be passed retrograde through the glans from one of the penile fistulæ or from the perineal drainage wound. In one case a definite valve-like stricture formed between the newly made anterior urethra and the old urethra. We succeeded in curing this by passing a small trocar from the perineal wound anteriorly out through the diaphragmatic stricture.

Although several operations were often required, in almost every case the final result was excellent—penis straight, urethra present to the glans or immediately behind it, micturition free, only one or two very minute pinpoint openings present, if not completely closed.

In some cases the skin flaps have been staggered, according to the plan of Thiersch for epispadias, so as not to bring the line of external sutures directly over the internal line of suture (Fig. 946). We cannot say that this was generally more successful than the ordinary Duplay method, which has usually been employed.

Churchman[1] has analyzed the various methods for penile hypospadias and speaks enthusiastically of Bucknall's operation, which may be briefly described as follows: The penis is laid back on the pubis and two parallel incisions $\frac{1}{4}$ inch apart made in the skin on the ventral surface of the penis and continued down an equal distance upon the scrotum. The skin is dissected up externally, producing raw surfaces on each side, which are sewed. The penis remains thus sutured to the scrotum until good healing has occurred, and three or four weeks later the penis and scrotum are separated by incisions which include a broad area of scrotal skin.

[1] Annals of Surgery, 1920, pp. 487–493.

This leads to a broad denuded area on the posterior surface of the penis which is covered by approximating the two edges of the skin dissected up from the scrotum, which is itself closed by transverse sutures. In this way a new urethra has been formed, one-half from scrotal skin and covered entirely by scrotal skin.

We have found complete penile hypospadias too extensive for skin and vein transplants. The cases in which they have been tried have not succeeded, but this may be due to faulty technic and, in view of Nové Josserand's enthusiastic advocacy of the method and the agreement of Legueu and other French writers on the subject, we feel that this method should be given further trial. Legueu[1] is also very enthusiastic about the use of the saphenous vein and describes with beautiful illustrations the method of Tanton, which is quite similar to the technic of Nové Josserand for skin transplants, except that the anastomosis is made direct with the congenital end of the urethra and not drawn through from the perineum.

Cantas has described a very ingenious modification of the vein plastic in which the saphenous vein is left attached to a flap of overlying skin, which is finally, at a second operation, brought over and sutured beneath the penis, so as to form a penile and glandular urethra. We have never attempted this operation and Legueu only mentions one case in which it has been done.

Rochet has proposed a modification of Nové Josserand's operation in which a flap is taken from the skin of the scrotum, formed into a urethral tube, drawn over the congenital urinary meatus, which is thus closed by it, and carried forward in a tunnel beneath the skin of the penis to come out at the glans.

It is our experience that practically all grafts live. Keyes, who has employed the method of Rochet, in 2 cases, reports one complete success and one partial failure. The Nové Josserand operation has later been modified by its author[2]: The curvature of the penis is corrected; perineal urethrostomy is performed; the urethra is dissected for 2 to 3 cm. back of the hypospadic meatus, and then ligated so as to close its orifice permanently. It is then buried beneath the skin sutures, thus closing the congenital meatus and leaving the buried urethra closed anteriorly, but (of course) draining posteriorly into the perineal urethrostomy. About two months later another operation is performed. A trocar and cannula is passed from the perineal urethrostomy outward through the urethra anterior to it, puncturing the end previously ligated, and then burrowing through the tissues between the corpora cavernosa and the skin of the penis to the glans, which is penetrated at the proper place for a natural meatus. The trocar is removed, leaving the tube in place, and through this is drawn a graft of the whole skin (about 4 cm. wide and 50 per cent. as long as the new urethra) which has been previously taken from the external surface of the thigh. This skin graft is wound spirally around a No. 14 F. catheter (epidermis inside) and held at each end by a ligature of catgut. A delicate forceps is introduced from the glans backward through the cannula and out the posterior end. The catheter is grasped and drawn back through the cannula, carrying the graft with it, after which the cannula is removed, leaving the graft and the rubber tube within it projecting from the summit of the glans. At the end of a week a heavy silk suture is fastened into the lower end of the catheter,

[1] Traité Chirurgical d'Urologie, 2d ed., Paris, 1921, ii, 1696–1756. (See 1734, 1738.)

[2] Journal d'Urologie, 1914, v, 393–406. (See also Archives Général de Chirurgie, 1909, No. 25.)

which is then withdrawn, carrying the suture into the new canal where it is left. Four days later the silk suture is tied to the tip of a No. 12 F. bougie, which is then gently drawn through the new canal and withdrawn again, leaving the thread in place. Thereafter dilatation is carried out twice a week with a 15 F. sound for two months. After the third or fourth time, the silk ligature may be removed. If stricture forms, internal urethrotomy may be done along the roof. If a fistula is present at the junction of the old and the new urethra, it will probably close by itself, after which the perineal urethrostomy is closed by a third operation.

Penoscrotal hypospadias is that form in which the meatus is at the penoscrotal juncture. In these cases there is apt to be more contracture and congenital chordee than in the penile type. In the preliminary operation to straighten the penis, two transverse incisions with dissection of the fibrous contracting tissue

FIG. 947.—Hypospadias, pseudohermaphroditism, cleft scrotum, urethra opening into perineal pouch between testes. Penis markedly retracted. B. U. I. 12,513.

and closure longitudinally by the Heinecke principle may be necessary. The preliminary perineal drainage should always be done before any operative procedure is attempted and the ultimate formation of the urethra left for the second operation. In these cases we have employed the Duplay plastic in the greatest number of cases and generally had success, but owing to the great length of the new urethra to be formed, there are apt to be two or three points of breakdown with formation of fistulæ. At times these are mere pinpoint openings and cause so little trouble that the patient does not return for operation, but some of them are larger and may be a great nuisance. It is on account of the secondary fistula that the Duplay operation has lost favor. Some form of skin-graft, according to the method of Nové Josserand or Rochet, may be found preferable. The technic is practically the same as has been previously described for posterior penile types of hypospadias.

We have employed with success a scrotal flap from which the new urethra is formed, the penile skin being approximated from side to side over the new transplant. In cases of deficient skin this may be distinctly preferable to the Duplay operation. We have never used the method of Bucknall, in which the penis is sewed down to the scrotum and liberated later.

Perineoscrotal Hypospadias.—In this form the scrotum is always bifid and the testicles are generally only partly descended, so that the scrotal halves have the appearance of labia. The penis is usually short, markedly curved and drawn backward, and often undeveloped. Many of these cases have a distinct feminine

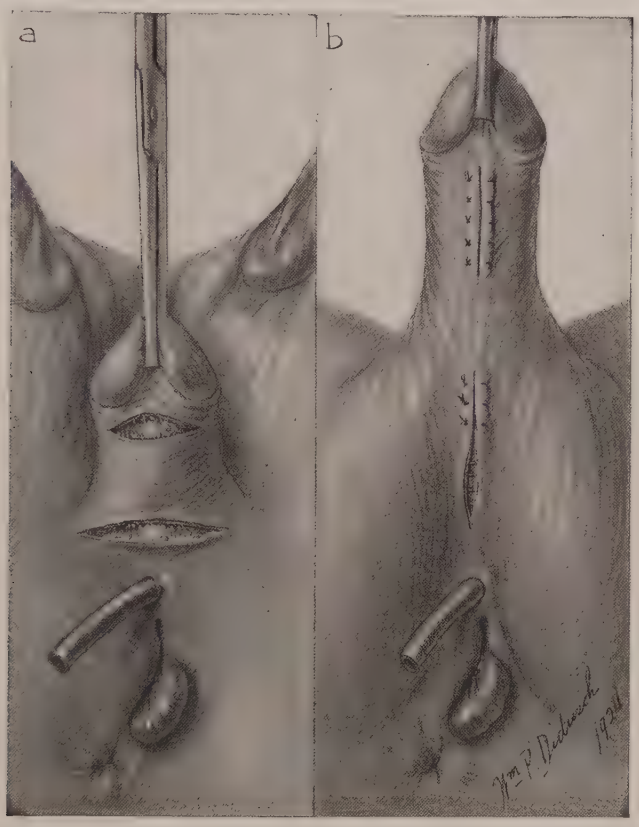


Fig. 948.—Primary operation to cure hypospadias, posterior perineal type, with pseudovagina 3 inches long in front of anus. Urethra opens immediately in front of this and in it a catheter has been placed. *a*, Incisions for lengthening operation for congenital chordee. *b*, Penis lengthened and drawn out beyond the cleft scrotum. B. U. I. 12,500.

type, though not quite so much as the posterior perineal, which are still be to described. In the perineal-scrotal type of hypospadias the urethral opening is so far back that perineal section is usually not possible, but the drain through the short urethra is so remote from the major part of the operation on the penile and glandular urethra, that it is quite safe to drain with a catheter through the congenital opening in the perineum, or even to have the patient void naturally, care being taken to avoid soiling of the wound. The preliminary straightening operation is most important; is a much more extensive procedure, and may require three transverse cuts, with considerable dissection of the restricting fibrous bands

and cords in the median line and between the corpora cavernosa in order to straighten the penis completely. On account of the great length of the new urethra to be made, some form of skin-graft, as previously described, is probably always preferable in these cases.

Posterior Perineal Hypospadias.—In this type the urethra usually opens into a pouch in the perineum. This pouch really suggests a vagina and in some cases extends back for a considerable distance behind the opening of the meatus, as exemplified in one case (Fig. 947). These are the types that may furnish the most pronounced pseudohermaphroditism. In a recent case (Figs. 603–605, 949), the pseudovagina was at least $3\frac{3}{4}$ inches (9 cm.) long. The urethral orifice was very much like the normal female meatus, while the small retracted penis suggested an enlarged clitoris, and the bifid scrotum, the labia. In this case, it was necessary to make two transverse incisions with dissection of scar tissue in order to lengthen and liberate the penis. After this was done it was quite remarkable to see the transformation made. The penis, which was previously held far backward, and so completely covered by the bifid scrotum as to be practically invisible and to suggest on examination only a hypertrophied clitoris, was now at least 10 cm. long and fairly normal in appearance. We have had 3 of these cases recently, but, as yet, have not completed the operation, though we have started with the preliminary plastic. In one case operated by others on our staff, numerous efforts were made to form a new penile urethra, but with little success. This may have been due to the fact that the patient was really a female who had been brought up as a boy and insisted on remaining so and wanted to have a penis with a urethra in it.

A case of pseudohermaphroditism, a girl, but brought up as a boy, and insistent on remaining so. The history was as follows: B. U. I., 4422, R. S., age ten, admitted June 8, 1915 for hypospadias and undescended testicles. His habits are those of a normal boy, he spurns girlish pursuits, and much prefers such games as football. Since birth, the urethra has opened at the base of the penis and the testes have not descended. There is a considerable amount of fine hair on the upper lip; axillary and pubic hair abundant, the latter showing female type of distribution. Genitalia: The phallus is represented by an organ 5 cm. long, curved markedly toward the ventral surface. A hooded foreskin is present, covering the glans, which is well developed, but has no urethra. At the base of this structure, on the dorsal surface between it and the slightly prominent mons, the skin lies in a fold and encircling the phallus, forms a bifid scrotum. No testes or spermatic cords are to be felt. When the glans is drawn upward, the opening of the urethra is seen at a point corresponding to the penoscrotal juncture. There is a marked chordee. The perineum has no depression. There is nothing to suggest a vagina or labia minora.[1] Very careful measurements were those of a boy from three to six years older than our patient.

June 14, 1915: Operation. A perineal section for drainage was carried out and a plastic on the penis to excise the fibrous tissue and lengthen and straighten the penis. A left inguinal incision was then made and the canal explored, but no cord or vas was found. The incision in the abdominal wall was prolonged upward and the peritoneal cavity opened. The pelvis was explored and a well formed uterine fundus and right tube and ovary delivered into the wound. The left tube and ovary could be palpated, but not delivered. The right ovary and about 2 cm. of the right tube were then removed for histologic examination. Examination of the specimen showed an ovary 2.5 by 1.3 by 1.7 cm. in size. Section of the ovary showed typically normal structure with Graafian follicles containing ova in various stages of development. The Fallopian tube also was normal. The sex of the individual must always be determined by the nature of the gonad, consequently this patient was of the female sex in spite of the characteristics of the opposite male sex. The individual seemed to possess a degree of maleness considerably greater than we

[1] Quinby: Johns Hopkins Hospital Bulletin, 1916, xxvii, 50–53.

see in normal children at ten years of age. The situation was explained to the parents, but their ardent desire was to have the patient remain a "male" and on this account, numerous attempts were made to form a urethra. At the second operation, the saphenous vein, 6 cm. long, was used. This operation was partially successful and a third operation was done to give him a glandular urethra, with some success. As time went on, however, strictures developed and additional operations were done to try to cure these defects, but without success. The urine continued to come out at the "penoscrotal" juncture and the urethra formed by plastics had practically disappeared.

Other operations for abnormalities of the sexual organs which accompany these cases are so varied that we only have space to refer briefly to them here. It is frequently necessary to operate in order to bring down undescended testes and this should always be done before puberty, but not too early, as described elsewhere. The bifid scrotum, which in the empty state so closely resembles labia majora, should be united in the median line by a proper plastic operation—after the urethra has been restored to its normal position at or near the end of the penis, liberated by a previous plastic operation.

A pseudovagina, if in the shape of a very shallow pouch, may require no attention, but where it is deep, excision would always seem to be indicated when the male character of the patient has been definitely proved. This is what we did in the one case we have had, the "vagina" being 9 cm. long (Fig. 948).

In an interesting case reported by Dr. Cullen, the habits and desires of the patient were respected and "she" was allowed to remain a "woman," although penis and testicles (undescended) were present. In a third case, described elsewhere,[1] there was a testicle on one side and a uterus, tube, and ovary on the other (see page 121). The patient, of a sturdy male character, is attending a boys' school and is a notable athlete; his desires are wholly masculine—all of which made it essential to remove the female organs which had been disclosed at operation upon the groin for supposed undescended testicle. Description of these remarkable cases is taken up elsewhere.

Other interesting cases are abstracted in the following pages. They are given in detail in order that the treatment required may be thoroughly presented. Perusal of these records will give an excellent idea of how complicated the problems often are.

Penile Hypospadias. Nové Josserand Operation, with Thiersch Skin-graft.—B. U. I. 4756, C. McN., twelve years, admitted December 3, 1915. The penis is small, much shortened, curved, and constricted on its under surface. There is a penile hypospadias about 1.5 cm. back of the glans, which contains no urethra. Both testicles are descended and negative.

First operation, December 6, 1915: Excision of fibrous tissue, straightening of the penis, closure of skin longitudinally. Catheter drainage through perineal urethrostomy. Result excellent. Wound healed well, penis straight.

February 28, 1917 (fourteen months since operation): The penis is straight and the urinary meatus is now at the penoscrotal juncture. Operation: External urethrotomy for drainage, formation of a pendulous urethra with a Thiersch graft according to the Nové Josserand technic. A trocar was introduced into the region where the external meatus should have been and the course directed down through the corpus spongiosum to the external urethral opening, the distance being about 3.5 cm. Filiforms and followers dilated this opening up to 20 F. A Thiersch graft was then taken from the right side of the thigh and placed around a small rubber tube, the skin being held in place around the tube with catgut. The tube was drawn out through the tunnel in the glans and the penis, and fastened with sutures at the glans.

[1] Young: Johns Hopkins Hospital Bulletin, 1924, xxxv, 165–168.

March 15, 1917, rubber tube removed in one week: The skin graft appears to have taken throughout. Filiform and followers passed through the newly formed urethra into the bladder.

May 11, 1917: Small plastic operation to close urethral fistula at site of congenital meatus. Fine catgut used to invert skin edges and to close outer flaps over these.

May 26, 1917: Operative result excellent. Wound healed perfectly. Voids all of urine through the normal urethra.

June 8, 1917: Patient admitted for a series of dilatations. No difficulty experienced in passing filiform and followers Nos. 14 and 16 F. There is a minute opening at the penoscrotal juncture, otherwise the result is perfect. Filiforms and followers were passed at stated intervals. By November 9, 1920 it was possible to pass a No. 28 sound, the patient voided urine freely and no fistula was present in the penis.

September 19, 1921: He now has normal urination. At times there is a slight leak in the perineal scar (drainage site). He has normal erections, but there is no history of coitus. Operative result is excellent. Patient discharged.

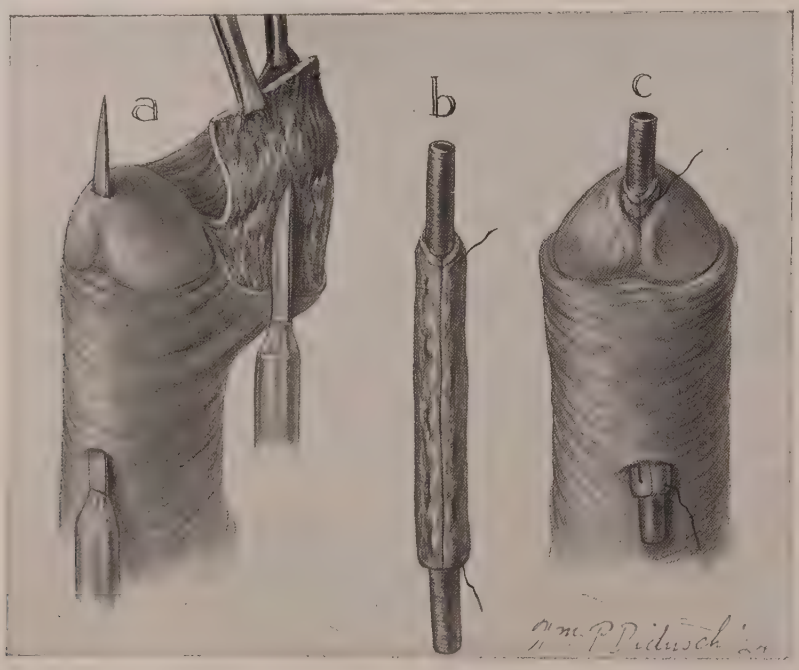


Fig. 949.—Penile hypospadias: Utilization of foreskin, *a*, to furnish tubular skin transplant, *b*. *c*, Tubular graft in place. B. U. I. 4779.

Penoscrotal Hypospadias, Skin Graft from Prepuce.—B. U. I. 4779, L. C. B., twenty-eight years, admitted December 26, 1915. Two operations have been performed elsewhere for hypospadias. The first operation was to correct a curvature, and the second, with perineal section for drainage, to form a new urethra. In all, four operations have been done, but have been unsuccessful. The penis measures 5 cm. in length and even in the flaccid condition there is considerable bowing. The foreskin is hooded and very redundant. The glans penis is notched and 5 cm. behind it at the penoscrotal juncture there is the opening of the urethra. There is considerable scar tissue on the under surface of the penis resulting from previous operations. The normal corpus spongiosum is missing along the penis. The scrotum is normal.

Operation, May 31, 1916: Young; gas and ether anesthesia. Plastic operation to cure hypospadias, transplantation of tube of skin made from the foreskin, rolled around a No. 12 F. catheter and inserted in a tunnel extending from the tip of the glans to the urinary meatus at the penoscrotal juncture. The operation is shown in Fig. 949. The tunnel was formed by making an incision at each end and then connecting them by blunt dissection, finally passing a Kelly clamp through the tunnel and dilating the tissues. The foreskin, which was very loose and

redundant, was picked up at four places with Allis clamps, a strip of skin 2.5 cm. wide and 12.5 cm. long was excised. This was placed around a catheter and the skin edges turned inside by means of a continuous fine catgut mattress-suture, as shown in Fig. 949, *b*. At one end the skin was cut obliquely and pared, so as to facilitate entrance to tunnel. By means of a Kelly clamp the catheter and tube of skin were drawn through the tunneled canal and projected from the wounds at both ends. To form a glandular urethra an incision was made deep into the glans on each side of the furrow and the cut surfaces brought together with interrupted sutures so as to cover the tube transplant. These were the only sutures used. The skin projected about 5 mm. beyond the glans and a similar distance through the posterior wound at the congenital urinary meatus. Perineal section and catheter drainage were provided. June 14, 1916: The patient has had an excellent convalescence. A perineal drainage catheter was left in place about eight days. Two days later the urine began to flow through the congenital meatus at the penoscrotal juncture and two days after that the perineal fistula closed. On the eighth day the catheter was removed from the transplanted urethra and not replaced. On the fifteenth a filiform was easily passed through the new urethra, from the glans and out the opening at the penoscrotal juncture, and followers up to 26 F. were introduced with ease. Examination now shows no slough whatever of the transplanted skin except at the lower portion, which projected from the wound. There is a slight necrosis of the skin overlying the transplant near the lower end. There is still an opening at the congenital meatus as no attempt was made to close it, this being left for subsequent operation.

December 2, 1916: Patient returns for observation. The attempt to reconstruct the urethra has been very successful and from the glans to a point about 1 inch posteriorly there is a passage which admits a No. 12 F. follower. Posterior to this the urethra is still open for a distance of about 1 inch.

February 7, 1917: The patient returns for completion of operation. The condition is shown in Fig. 950. As seen here, there is a good meatus in the glans and a urethra posterior to this about 3 cm. long. The urethra is absent for a distance of 2 cm. The penis is quite straight. Operation: Plastic operation to close opening remaining after transplantation of skin. Preliminary perineal urethrotomy with insertion of catheter for drainage. Duplay technic employed.

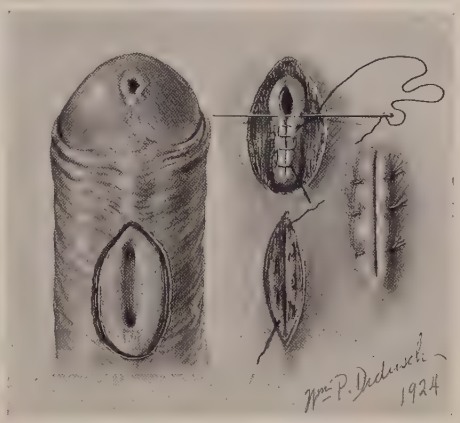


FIG. 950.—Hypospadias. Final closure of breakdown of previous operation (catgut sutures). B. U. I. 4779.

The new urethra connecting the two openings was made, as shown in Fig. 950. The skin was dissected up slightly on each side and around each orifice and then closed around a small-rubber catheter which had been inserted through the meatus, by means of a continuous Cushing mattress-suture. When this was complete a second line of sutures was taken with the same needle in an opposite direction and the third brought together the subcutaneous tissues over the first two layers. The skin was approximated with three mattress-sutures of horsehair, placed so as to approximate broad areas as shown.

February 11th: Pus is present at site of plastic.

February 14th: Catheter removed from the pendulous urethra. Perineal catheter came out and was not replaced.

February 20th: Perineal wound apparently closing. Voids through new meatus in glans. Two small fistulæ about 1 inch back of the new meatus.

Scrotal Type Hypospadias with Marked Chordee and Bifid Scrotum. Extensive Case. Duplay and Scrotal Flap Technics.—B. U. I. 5559, C. C. H., twenty-one years, admitted November 25, 1916. The patient is a strong, healthy looking man, complains of marked downward curvature of the penis, pronounced chordee on erection, and meatus far back between the testicles. Libido, erections, and nocturnal emissions natural. Never attempted coitus owing to the curvature. The scrotum is bifid. The penis is small and retracted backward between the two testicles which

are separated by a deep cleft. The urinary meatus lies far back in the bifid scrotum, and is 6 cm. posterior to the small retracted glans penis. Testes normal. Rectal examination: The membranous urethra is prominent and possibly a little longer than normal. Immediately above it in the median line there is a depression which easily admits the end of the finger. The prostate cannot be made out. The lateral lobes are not palpable. The seminal vesicles can be made out definitely.

January 15, 1917: Operation, Davis. Perineal urethrotomy for drainage. Plastic to cure curvature of penis.

Convalescence: Stitches removed on fifth day. Perineal catheter on tenth day. Urine infected with bacilli. Patient complains of urinary urgency and frequency. On the eighteenth day, developed acute appendicitis and his appendix was removed. Patient was discharged four weeks after the urethral plastic, in excellent condition.

April 23, 1917: Patient returns for operation. The glans has only a dimple, but no definite urethra. The urinary meatus is at the penoscrotal juncture. Operation, Davis and Burns: Duplay plastic to form penile urethra; Russel skin transplants through tunnel in glans to form glandular urethra (Figs. 951, 952). The inner surfaces of the scrotum, which had been exposed

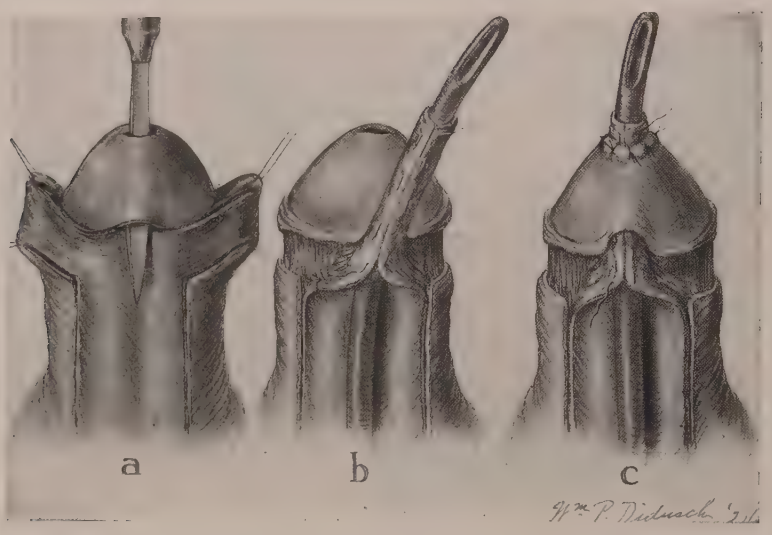


Fig. 951.—Glandular and perineal hypospadias. Operation after preliminary straightening. Glandular urethra from two preputial flaps, continuous with Duplay plastic, for penile urethra. *a*, Skin incisions; *b*, formation of glandular urethra from foreskin; *c*, ready to form penile urethra by Duplay method. B. U. I. 5559.

in forming the flaps to make a new urethra, were drawn together so as to cure the bifid condition (Fig. 953). There was considerable tension on the penile skin and a longitudinal dorsal incision was made to relieve this; closed transversely, horsehair sutures throughout. Retention catheter through perineal fistula; a small catheter in newly formed urethra. Convalescence: The perineal catheter was removed on the seventh day, the penile urethral catheter on the eighth day, horsehair sutures on the eleventh day. Wound in excellent condition except at the penoscrotal juncture where there are a few drops of pus. Slight cystitis. Patient discharged with a fistula in the perineum and at the penoscrotal juncture. On July 20, 1917 the patient returned and underwent a plastic operation on the penis to close the urethral fistula at the penoscrotal juncture. Before starting operation sounds were passed from the new meatus back to the external urethrotomy wound in the perineum, up to 22 F. A rectangular incision was made around the opening in the urethra at the penoscrotal juncture, the skin flaps freed, and the edges freshened. The inner flaps were turned in on a catheter in the urethra and sutured with fine catgut. The external skin edges were approximated with interrupted sutures of horsehair, catheter then removed.

July 31: Sounds and irrigation fluid were passed through the new urethra today. No leakage.

August 6, 1917: External urethrotomy wound persists and was closed today by means of lateral skin flaps; catheter drain through urethra.

August 23d: Sounds up to No. 22 readily pass through both sites of urethral repair and back to the bladder. Patient voids naturally through urethra.

April 9, 1922: Final note. It is now six years since the first operation. Patient has been married nearly two years. Sexual intercourse is normal, except that the semen does not escape from the meatus until withdrawal and when the penis has become flaccid. The erections are perfect, erect penis has only a very slight curvature. All fistulæ are closed and a No. 24 F. sound passes with ease. The urine is clear. An *x*-ray plate, after filling the urethra with thorium ni-

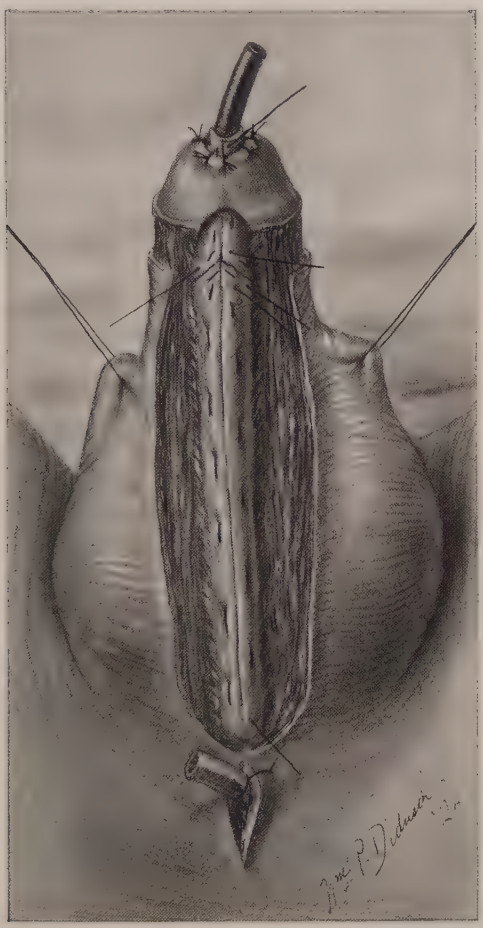


FIG. 952.—Operation for perineal hypospadias, showing formation of new urethra with glandular portion made from foreskin (Russell) as shown in Fig. 951. Penile and perineal urethra made by Duplay technic with continuous mattress catgut (Not now advised.) Perineal tube drainage. B. U. I. 5559.

trate, 15 per cent., shows three marked dilatations of the urethra, one in the region of the triangular ligament as shown in the accompanying plate (Fig. 954). General condition is excellent.

Hypospadias, Scrotal, Marked Chordee, Various Operations, Including a New Skin Tube. Plastic to Lengthen Urethra.—B. U. I. 5562, R. W. W., thirty-six, admitted December 11, 1915. Patient complains of a hypospadias with marked retraction of the penis which, on erection, is so bent as to make intercourse impossible. Sexual desire normal. Has undergone one operation to straighten the penis one year ago. Examination: The patient is a sturdy man. The scrotum is bifid and between the testes is the opening of a hypospadiac urethra. The penis is shorter than normal, bent backward by a septum which draws it back to the bifid scrotum. The foreskin is

markedly hooded. Both testicles are present and normal. The prostate is about three-fourths normal size. Two small cords can be felt in the region of the seminal vesicles.

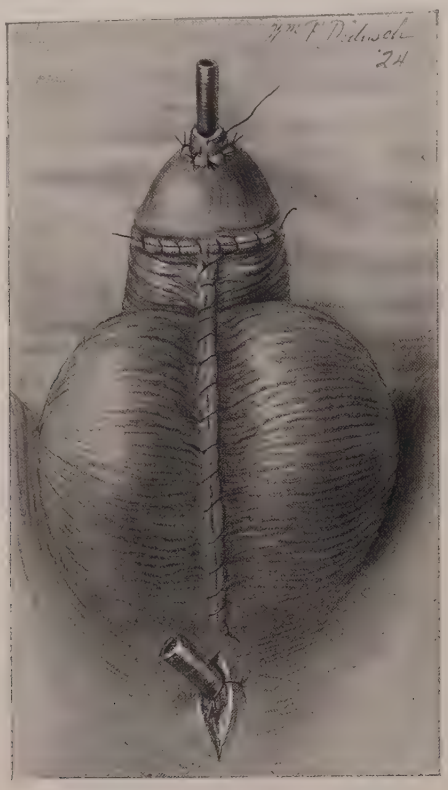


FIG. 953.—Perineal hypospadias, final closure. The bifid scrotum has been cured by proper sutures. Perineal drainage. B. U. I. 5559.

December 15, 1915: Operation, Davis. Duplay plastic to form penile urethra. Drainage through congenital meatus with catheter. December 22, first dressing. Wound looks clean, healing *per primam*. Horsehair stitches removed today. There remain only the silk stitches through the glans. The patient has been taking "Triple Bromides," grains 100, b. d. December 28, 1915: Bladder drain removed today. Slight urethritis present. Patient has not had an erection since operation.

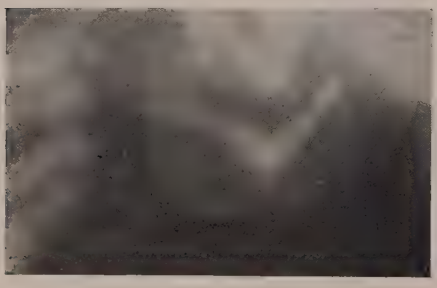


FIG. 954.—Urethrogram taken in a case of perineal hypospadias after successful reconstruction of the entire urethra. Note the regular character of the penile portion and the irregularity with alternating dilatation and constriction of the perineal portion where the reconstructed urethra joins the pre-existent urethra. B. U. I. *x*-Ray 3587. B. U. I. 5559.

January 9, 1916: Patient discharged today. Voiding largely through the posterior opening. Wounds well healed. No sounds passed.

March 15, 1917: Patient returns for further operation (no history of having had sounds passed). He has a small opening 1.5 cm. back of the newly formed meatus through which a filiform can be passed. The rest of the urethra is closed.

March 18, 1917: External urethrotomy; plastic to close urethral fistula at old hypospadias opening and also at base of glans; lateral flaps, fine catgut sutures, covered with skin flaps, horsehair sutures over a No. 16 F. catheter which was left in the urethra.

April 5th: It is now twenty days since operation. The rubber tube was removed from the

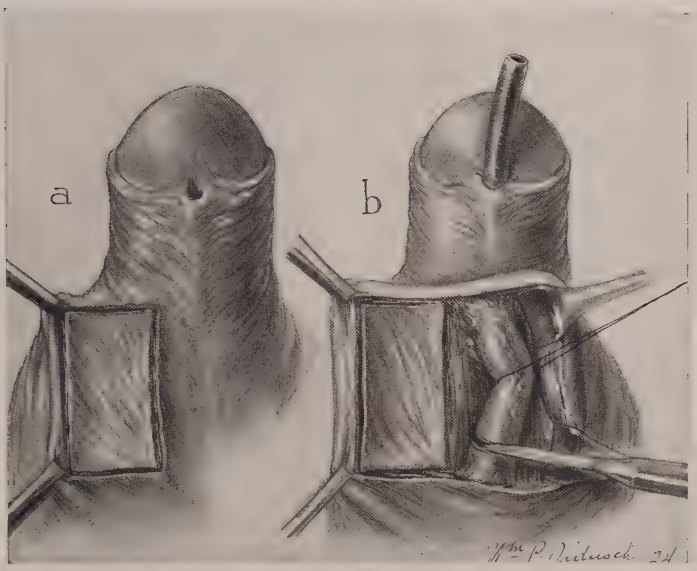


FIG. 955.—Previous hypospadias. Urethra successfully formed without proper lengthening. Resultant marked curvature due to short urethra. Skin flap used to lengthen urethra. *a*, Skin incisions mapping out flap to form a new urethral segment; *b*, exposure of urethra (result of previous plastic) preliminary to its division, for lengthening. B. U. I. 5562.

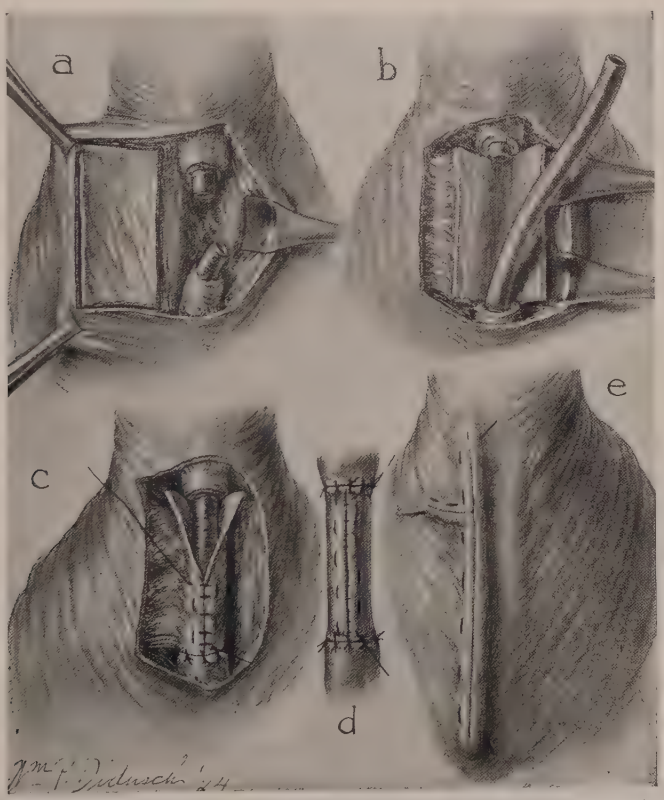


FIG. 956.—Completion of operation to lengthen urethra by inserting tube of skin subcutaneously. Buried catgut used. *a*, Urethra divided, formation of skin flap; *b*, skin flap pulled over between ends of divided urethra; *c*, formation of tube; *d*, completion of new intercalated portion of urethra; *e*, closure. B. U. I. 5562.

anterior urethra on the eighteenth day, the perineal on the twenty-second day. There is a small fistula at the site of the original hypospadias opening and three small fistulæ in front of this. The patient says that when the penis is erect it is still bent downward considerably. May 15th: Only one fistula now present. Most of the urine comes out through the glandular meatus. The penis is markedly curved and very bent on erection. May 21, 1917: Operation, Davis. Closure of urethral fistula which is present, about 2 cm. back of the urinary meatus and 2 mm. in diameter. This fistulous tract was excised and the edges turned in with interrupted sutures of fine chromic catgut and the skin approximated with horsehair. May 30th: Wound healed by first intention. Patient discharged. Remarks: The result of this operation was a completely closed urethra and normal urination through the meatus, but the patient had a marked curvature of the penis, due to the very greatly shortened urethra and downward contracture. This is undoubtedly due to the fact that at the very beginning the patient did not have a straightening operation by the Heinecke principle, but the plastic was done without preliminary straightening. This undoubtedly was a serious error.

November 9, 1919: Patient admitted complaining of marked curvature of the penis interfering with sexual powers. On intercourse, he says that it "curls up," making entrance very difficult. Urination normal through artificial urethra. On examination it was found that the penis was short and curved downward. The urethra was complete and the urine passed out through the meatus in the glans normally, but the new urethra was so short that the penis was markedly curved and on erection bent backward. The problem which presented itself was a new one, in that the urethra was complete and the only complaint was curvature due to the shortening of the urethra. It was decided to operate with the object of dividing the urethra subcutaneously and intercalating a tube of skin to lengthen it.

October 12, 1919: Operation, Young; gas and ether. Formation of a tube of skin from the penis and scrotum. This was left attached by a pedicle of subcutaneous tissue on the inner side, as shown in the accompanying drawings (Figs. 955, 956). Insertion of catheter into the urethra, subcutaneous freeing of urethra from surrounding structures, transverse division of urethra. Wide separation of the two ends of divided urethra, between which was placed the newly made tube of skin. Fine catgut sutures around catheter to form anastomosis between old and new urethra at each end. Closure of skin wound over plastic with continuous Cushing mattress. The region of the operation was covered entirely by the skin which had been lifted up, the object being to avoid a fistula connecting directly with the urethra.

December 24th: It is now seven weeks since operation. Suppuration occurred in region of plastic and considerable pus was evacuated. Urine, however, flows out through the meatus and partly through the perineal fistula.

May 17, 1920: Fistulæ closed. The patient has been dilated with filiform and followers up to No. 28 F. without difficulty. Urine is free from infection and the general condition is excellent. There is still some shortening of the urethra, but much improvement. Recently a calculus passed through the urethra from the bladder. The patient now voids urine with a good stream.

Comment: The result in this case as regards the formation of a new urethra is remarkably good. The mistake in not correcting the deformity of curvature necessitated two other operations, the last of which was successful. We believe that a silver probe should have been left in the urethra until anastomosis healed firmly.

Case of scrotal hypospadias with bifid scrotum. Heinecke and Thiersch plastics.

B. U. I. 8913, age nine years, admitted July, 1920. As shown in the accompanying photographs (Figs. 957, 958), the penis was held back by a congenital chordee between the halves of a bifid scrotum. About 2 cm. behind the glans the orifice of the urethra is seen in the cleft between the scrotal halves. There is a long hooded foreskin, but the penis cannot be retracted on account of a marked fibrous chordee. On rectal examination the prostate is palpable, but the seminal vesicles cannot be made out. Patient is otherwise normal.

Operation July 23, 1920: Young; ether. Transverse incision and dissection of fibrous tissue to relieve chordee. Transverse closure with catgut; Heinecke plastic. This completely liberated the penis. Perineal urethrotomy, insertion of rubber tube for drainage.

August 5, 1920: Convalescence has been very satisfactory except for one break in plastic which has healed by granulation. All wounds now closed; no perineal fistula. Plastic operation has been entirely successful in straightening penis.

June 18, 1921: Second admission. It is now eleven months since first operation and patient is ten years old. The penis is now quite straight and the distance from the glans to the opening of the urethra is about $3\frac{1}{2}$ cm. This opening lies in the posterior part of the scrotal cleft. Testes normal and located in scrotum.

June 20, 1921: Operation; gas and ether. Plastic operation by Duplay method to close hypospadias. Perineal section was first done and catheter inserted for drainage. The Thiersch method of flaps (Fig. 946) was used, the longitudinal incisions being so placed that the skin to form the urethra was covered by a flap which was brought over it from the opposite side. Mattress-sutures of fine silk, which were brought out through the skin on the left side and tied around a rubber catheter, were used. The glans was deeply divided on each side so as to bring the new meatus into a deeper position. Mattress-sutures were also used in the second line to approximate the skin. Tension was avoided everywhere.

Fig. 957.—Scrotal hypospadias with cleft scrotum. Photograph in standing posture. B. U. I. 8913.

June 26, 1921: The outer row of sutures was removed today. There are several stitch abscesses which were emptied and treated with 1 per cent. meroxyl. Deep stitches not removed. Perineal drainage maintained.

July 4, 1921: Suture closing urethra in front of perineal tube was removed today.

July 6, 1921: Patient voided a few drops of urine through penis first time today. Filiform passed through the new urethra.

Fig. 958.—Perineal hypospadias. Cleft scrotum. Left testis undescended. Congenital chordee marked. B. U. I. 8913.

July 12, 1921: Filiform and small follower were passed today without difficulty.

July 16, 1921: Patient discharged. Perineal fistula almost healed. Urination normal through new urethra.

July 20, 1921: No. 12 F. sound passes without difficulty.

September 13, 1921: Condition excellent; no fistula. Urine clear. Sounds passed.

August 16, 1921: Now two years since operation. No fistulæ present. Usually voids normally, but at times recently has had slight difficulty. Filiforms and followers up to No. 20 F. passed today.

January 9, 1924 (letter): The result has been excellent.

Hypospadias, Midscrotal Type.—B. U. I. 2986, W. G., aged eight months. Admitted October 8, 1911. Patient was first seen when six weeks old. At that time the parents were advised to bring him back in six months. He is now eight months old, very large boy. Testicles are large and epididymes normal. Scrotum is cleft-like and the urethral opening is midway between the testicles. The penis is markedly curved, urethra absent and the meatus about 1 inch from glans. Urethral orifice small, no blind pouches. Boy is apparently healthy in every other respect. October 18, 1911: Operation; nitrous oxide and ether. Operation to straighten penis preparatory to subsequent formation of new urethra. Transverse incision 1 cm. long through skin and fascia.

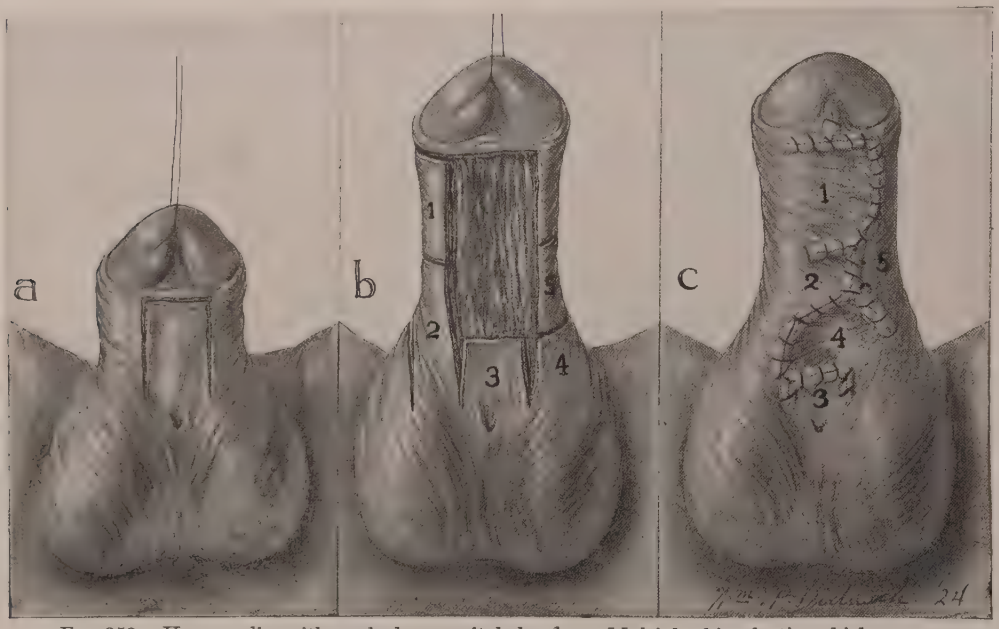


Fig. 959.—Hypospadias with marked congenital chordee. Multiple skin plastics which were necessary to correct defect are shown graphically. *a*, Incisions; *b*, fibrous tissue which caused chordee has been dissected out, greatly lengthening penis. Skin flaps have been projected. *c*, Showing how these flaps have been utilized to cover defect. Penis completely liberated. B. U. I. 2986.

It was found impossible to lengthen the penis sufficiently in this way and lateral longitudinal incisions were then made 8 mm. apart in the sheath of the penis (Fig. 959), and between them the fibrous covering of the corpora cavernosa was excised. It was then found possible to push the glans forward and the urethral meatus backward, greatly lengthening the penis and making a wound 5 cm. long and 2 cm. wide. Penis was thus very greatly lengthened, in fact, almost completely freed. In accomplishing this it was necessary to open outer portions of corpora cavernosa and free them from adhesions along under surface of penis, which was finally lengthened to about three times as long as before. Flaps were then made so as to cover large defect on under surface of penis (Fig. 959, *b*). It was necessary to make three flaps which were twisted so as to cover the defect (Fig. 959, *c*.). A fine suture of chromic catgut was then placed so as to draw skin deeply into cleft between corpora cavernosa caused by excision of fibrous septum. This was to prevent recurrence of fibrous contraction and produce gutter for future formation of urethra. In so doing redundant skin of prepuce was drawn out of place and made use of for flap. One point of circular tension was present and a longitudinal incision was made along dorsum of penis and closed transversely so as to relieve this. The urinary meatus was now 6 cm.

from end of penis and situated well back toward the perineum. Wound covered with boric ointment, no urethral catheter drain. Diaper changed frequently and ointment re-applied.

The result of this plastic was excellent. The penis was entirely liberated, and greatly lengthened.

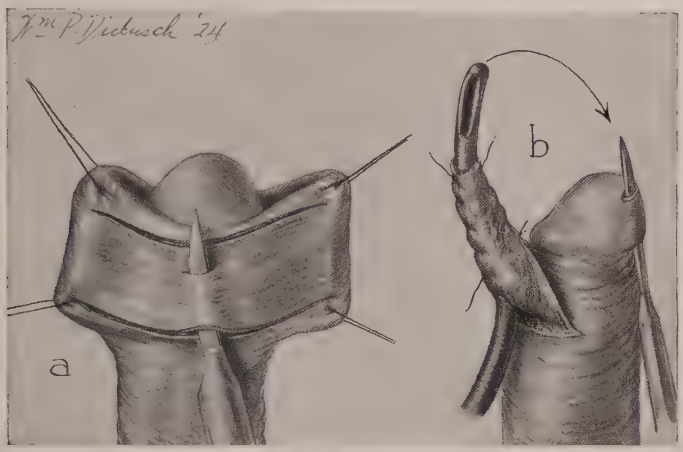


FIG. 960.—Hypospadias. Skin plastic to form glandular urethra from hood of foreskin: *a*, Dissection of flap from dorsum. *b*, Formation of urethral tube. B. U. I. 2986.

October 15, 1919: Patient returns for second operation. It is now eight years since the first operation to straighten penis was performed. Has grown to be very large, strong boy, apparently normal in other respects. Genitalia: There is a long redundant foreskin. The glans penis is normal in size, no urethra present in the penis. Very little scar tissue at site of previous operation. Penis is soft, can be drawn up quite straight and has no curvature. Urethral open-

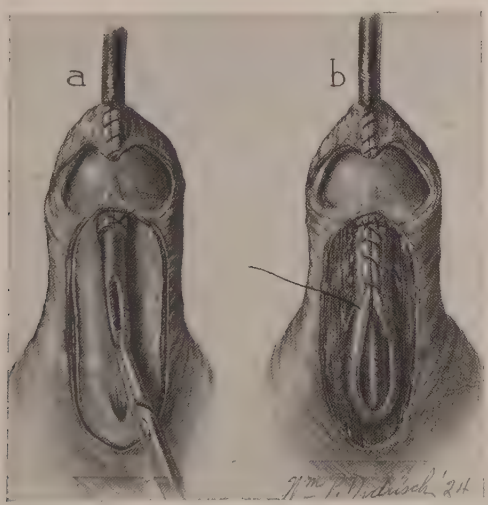


FIG. 961.—Penile hypospadias: *a*, Glandular urethra formed from tube of foreskin, brought down from dorsum; *b*, Duplay plastic to form penile urethra. Continuous catgut suture used in this case successfully. B. U. I. 2986.

ing lies between two halves of a bifid scrotum near perineum. Urethral opening is 7 cm. from the glans. Testicles are present and apparently normal, but situated somewhat high.

Second operation, October 27, 1919. Young. Nitrous oxid and ether. Operation carried out as shown in accompanying diagram. The glandular urethra was formed after puncturing with trocars of various sizes. Two transverse incisions were made in the hood of the foreskin across dorsum and the intervening skin elevated and completely separated except at the ends

(Fig. 960, *a*). These were punctured in the center, a catheter introduced and the skin sewed together around it with raw surface outside (960, *b*). Catheter then drawn through the tract of the trocar in the glans (Fig. 961, *a*). The penile urethra was then closed according to the Duplay technic. The flap was large and redundant so as to avoid tension and the edges were turned in around catheter by means of continuous Cushing mattress fine catgut suture as shown in sketch. At the anterior end it was anastomosed with the tube of skin through glans (Fig. 961, *b*), and skin then closed by means of continuous mattress-suture of horsehair. Perineal section for drainage.

November 15, 1919: Convalescence satisfactory. Healing has taken place *per primam.* Penis straight, tissues soft. Patient still voiding through perineal opening. November 24, 1919: Examination shows that the meatus is tight, will not admit a filiform. Three small fistulæ are present along the newly made urethra. November 25, 1919: Filiform and No. 10 follower passed without difficulty. November 27, 1919: Filiforms and followers, Nos. 12 and 16, passed through the new urethra. December 1, 1919: Filiform and followers to 17 F. passed under gas anesthesia.

April 29, 1920: Patient returns for closure of fistulæ. Since discharge from hospital patient has voided freely at normal intervals. Urine comes through meatus in a good stream and slightly through two small fistulæ, one about 5 cm. from end of penis and another within 1 cm. of the end. Perineal wound healed. Result of previous operation is as follows: Penis looks quite normal and is not curved or contracted. Meatus is large and fairly normal in appearance. Less than 1 cm. back is small orifice of a fistula. At a point 2 inches back, at the penoscrotal juncture, is another orifice about 4 mm. in diameter. Filiform and followers No. 22 F. passed into bladder without difficulty, no stricture. It is evident that the new urethra is of large caliber.

Third operation, May 3, 1920. Young. Gas and ether. Plastic to close two small penile urethral fistulæ. Perineal section for drainage with rubber catheter. Circular incision, dissection of surrounding skin, urethral opening closed with continuous mattress-suture of catgut. Same suture continued forward as through-and-through continuous suture for the skin and subcutaneous tissue. Subcutaneous tissues drawn together with similar suture of catgut inclosing posterior fistula and no skin suture used. As result of this operation condition was improved, but two very small penile fistulæ remained at the penoscrotal juncture. The penis is straight, of proper length and size, and the urethra large.

Scrotal hypospadias; Duplay plastic.

B. U. I. 7765, C. B., age five years, May 27, 1919. A boy, who was otherwise quite normal, presented a hypospadias which had been operated upon three times before without success. Examination showed a severe grade of scrotal hypospadias with marked contracture. First operation June 2, 1919, Young. (1) Transverse incision, division of scar tissue, longitudinal suture (Heinecke-Mikulicz), closure with chromicized catgut to draw corpora cavernosa together, horsehair for the skin. (2) Formation of glandular urethra by means of two parallel incisions deep in the tissue of the glans on each side of the urethral gutter. Closure around small catheter, two mattress-sutures of catgut, turning in of the skin edges. Wound closed with interrupted catgut. Catheter then removed, wound dressed with boric ointment.

June 16, 1919: Operation two weeks ago. The wound has healed *per primam* except in the center of the Heinecke-Mikulicz plastic. Glandular urethra is intact and operation apparently quite satisfactory. The congenital chordee has been practically eliminated. Penis fairly straight. Discharged.

November 10, 1919: Second operation, Young. Perineal drainage. Duplay plastic to form urethra and connect meatus with glans. Catgut used. Result good, but two small fistulæ.

December 13, 1919: Filiforms and followers to 16 F. easily passed through meatus into bladder, apparently no stricture. Two small fistulæ in the newly made urethra, one just behind glans at site of anastomosis and second about middle of pendulous urethra about 2 cm. in front of old meatus. Patient discharged.

February 2, 1920: Impossible today to pass filiform, owing to impenetrable stricture at the penoscrotal juncture. Probes were passed from the perineal fistula which is still present and showed that the stricture was membranous in character. Fine trocar was then passed retrograde through perineal fistula and comes out through posterior fistula, thus completely dilating stricture. It was then possible to pass filiform and follower up to 16 F. from meatus into bladder.

June 11, 1920: Operation, Cecil; gas and ether. Valve-like urethral obstruction just behind posterior penile fistula excised by enlarging fistula.

May 22, 1921: Patient returns for closure of fistula. All the urine has been voided through opening in the base of the penis following last operation of excision.

May 25, 1921: Operation, Deming; ether. Closure of fistulæ with interrupted sutures of silk which inverted edges of urethra and were brought out through skin and tied. Skin then closed by interrupted sutures of silk. Result: One very small penile fistula.

June 1, 1922: Readmitted for closure of fistula. Examination showed one fairly large mid-scrotal fistula and two pinpoint penile fistulæ. Boy is now eight years old. Voids urine through meatus in good stream, but some escapes through fistulæ.

June 11, 1922: Operation, Davis; gas and ether. Closure of fistula. Edges turned in by means of mattress-sutures which were brought out through skin and tied outside around rubber tube. Skin closed with mattress-suture around rubber tube. Result: Large fistula closed, two pin-point fistulæ remained. Patient discharged, condition excellent. Penis straight, urethra large, urination normal, with exception of pinpoint fistulæ restoration to normal practically complete. This is a good example of the difficulties encountered in getting final closure of all minute fistulæ.

Results.—A recent study of cases of hypospadias at the Brady Institute by C. Y. Bidgood shows 28 cases in which we have satisfactory reports of ultimate results. These have been tabulated as to type, and results are as follows:

TABLE 186

Analysis of Operations Performed in 28 Cases, and Results Obtained

Result.	Type of operation.								
	Glandular hypospadias.				Penile and scrotal hypospadias.				
	Mayo.	Russell.	Duplay.	Rosenberger.	Duplay.	Nové-Josserand.	Scrotal flap.	Thiersch.	Vein transplant.
Complete new urethra without fistula	...	4	5	...	...	1	1	1	
1 Fistula	1	1	2	...	7	1	1		
2 Fistulæ	...	1	...	...	8	...	...	2	
3 Fistulæ	...	1	...	...	2	...	...	1	
Unsuccessful	...	1	2	1	3	...	...	...	1

In this table the number of operations greatly exceeds the number of cases. Several different operations were often required in a case. The first plastics to straighten the penis are not recorded here.

By reference to the above table the large number of cases with fistulæ will be noted. The majority of them are very minute and cause so little trouble that the patients have not returned to have them closed. In 9 cases in which closure was carried out the fistula has recurred in only 2 cases. These fistulæ sometimes require several operations (especially when multiple) to effect a closure.

Our cases show that almost any of the above measures are quite successful, but that practically all have one or more pinpoint fistulæ after the first urethral plastic.

OPERATIONS FOR EPISPADIAS

The *operative cure of epispadias* depends upon the extent and character of the condition, and the presence or absence of incontinence of urine. When the pros-

tatic, membranous, and bulbous urethra are present, and the urethral defect is confined to the penis, the problem is simply to make a new urethra and place it

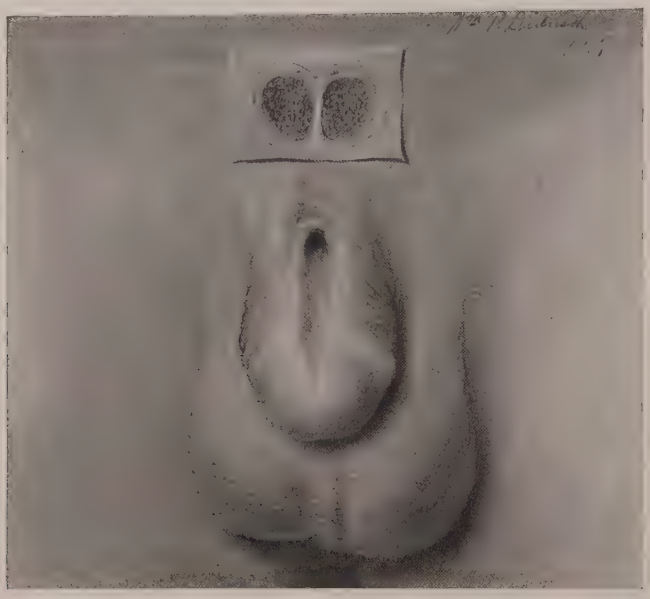


FIG. 962.—Epispadias without incontinence. Sectional view shows corpora approximated beneath urethral gutter. B. U. I. 6244.

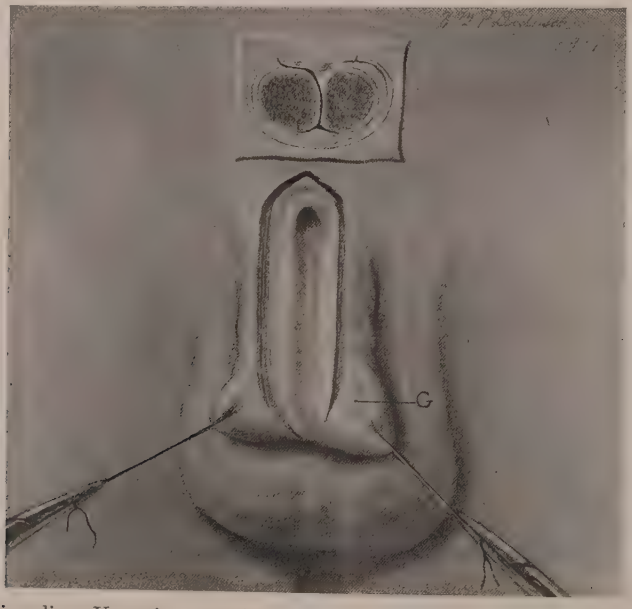


FIG. 963.—Epispadias, Young's operation. Skin incisions and plan of operation above. The penis is held in position by two traction sutures placed in glans (*G*). As indicated by heavy black line in diagrammatic cross-section, incision on left side goes only through skin and down to corpus, while, on right, dissection is carried down between corpora until skin of under surface of penis is reached. B. U. I. 6244.

in its proper position beneath the reapproximated corpora cavernosa. The technic which we follow was thus described in 1918[1]:

[1] Young: Journal of Urology, 1918, ii, 237–251.

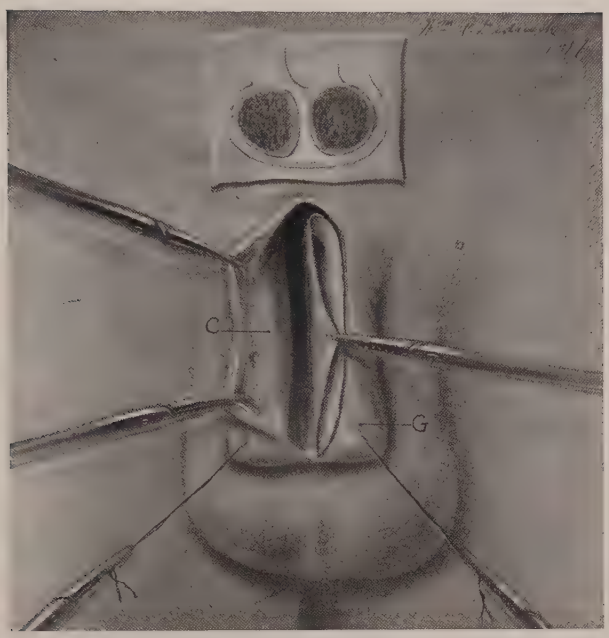


FIG. 964.—Epispadias, Young's operation. Separation of two corpora has been completed. Skin edge is being retracted to right and edge of new urethra to left, exposing right corpus (*C*) and exposing also space between corpora, the floor of which is formed by the inner surface of skin of under surface of penis. B. U. I. 6244.

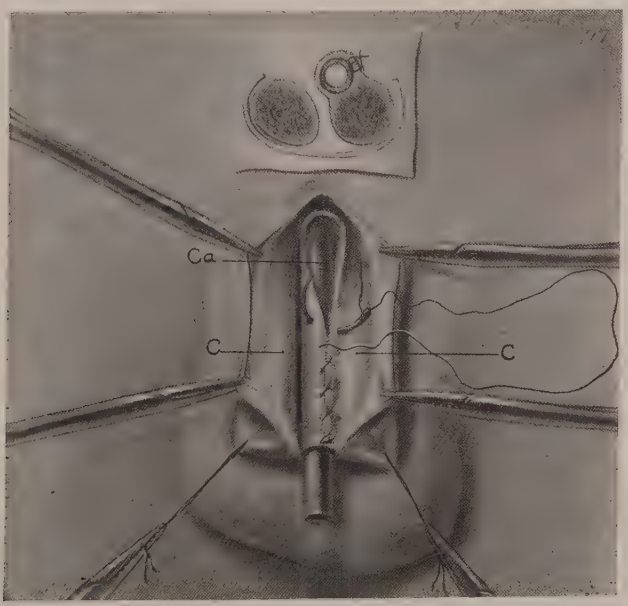


FIG. 965.—Epispadias, Young's operation. New urethra is being formed by continuous suture of catgut, bringing together over catheter (*Ca*) edges produced by original incision, and converting original groove into a tube. Attachment of urethral tube to left corpus may be distinctly seen both in surface view and cross-section. *c*, Corposa cavernosa. B. U. I. 6244.

Without knowledge of the previous work which had been done, I performed on November 3, 1913, a plastic operation which is somewhat similar though essentially different from Cantwell's operation. The technic which I employed is so graphically shown in the accompanying

illustrations, that very little description is necessary. The conditions present before operation are shown in Fig. 962, the cross-section indicating the anatomic relations of the corpora cavernosa and the roofless urethra, and showing the groove along the dorsum of the penis extending

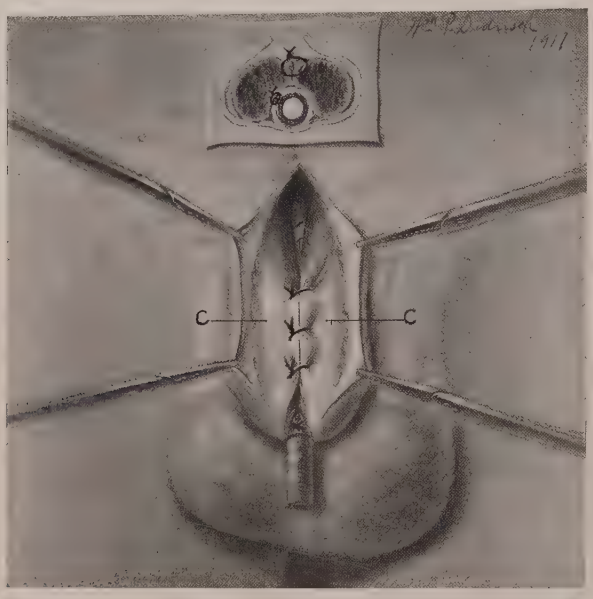


Fig. 966.—Epispadias, Young's operation. Right corpus (*C*) has been rotated, carrying urethra down to new position below and between corpora, which are being sutured with chromic catgut. Unfinished suture line above permits view of underlying newly formed urethra. B. U. I. 6244.

Fig. 967.—Epispadias, Young's operation. Operation completed. The outer two edges of original incisions were easily brought together in midline, making a penis and glans almost normal in appearance. B. U. I. 6244.

from the urethral opening at the base of the penis to the glans. As seen in the accompanying diagrammatic cross-sections, it was evident at once that in order to restore the urethra to its normal position on the inferior surface of the penis beneath the corpora cavernosa, a procedure

involving the separation of the corpora with transplantation of the new urethra would be necessary. In so doing it was also evident that the most important thing was to preserve the blood-supply of the skin transplant, and I accordingly decided to leave this attached by a broad connection along its entire length to the left corpus cavernosum, and rotate this structure with the new urethra so as to displace the latter to its new position beneath the corpora. The transplantation was thus accomplished without serious interference with blood-supply. This is graphically shown in Figs. 963–967. As noted in Fig. 964, the corpora cavernosa have been well separated, so that they are held together only by the skin on the under surface of the penis. A very deep groove, to be occupied by the urethra, is thus produced. The left corpus has been sufficiently mobilized to allow it to be rotated, carrying with it the urethral graft. Figure 965 shows the formation of the new urethra from the skin of the dorsum of the penis, and also the attachment

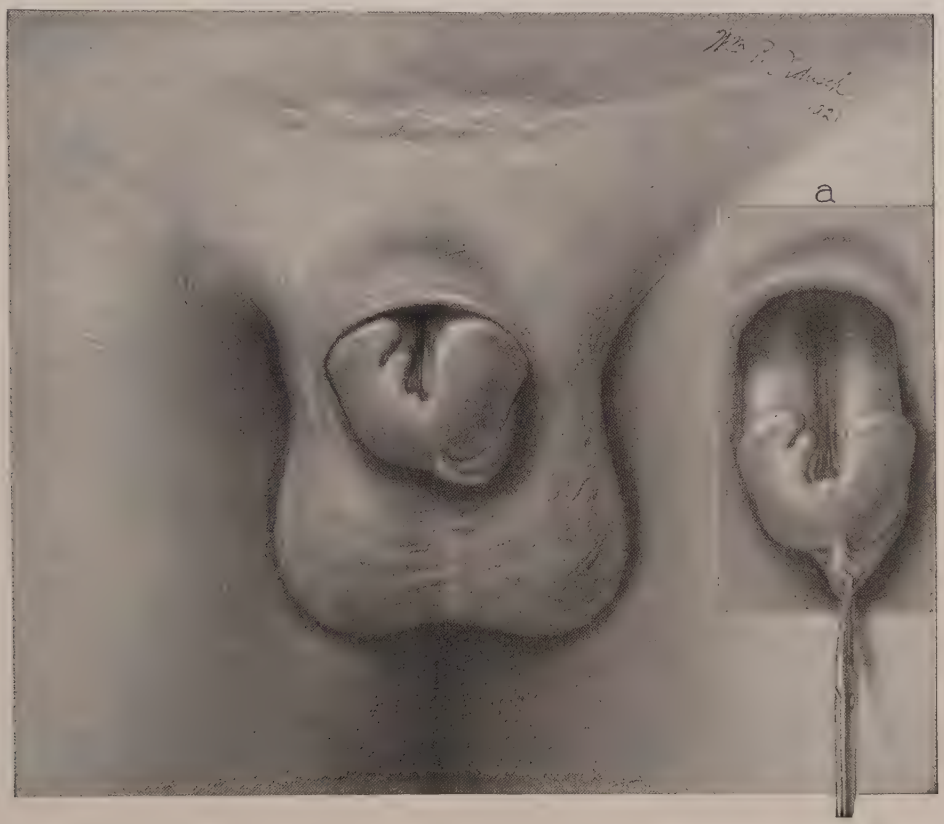


Fig. 968.—Epispadias with complete incontinence of urine. Note urethral furrow, glans only slightly bisected. Note scar of previous operation. *a*, Glans pulled down to show great depth of defect. B. U. I. 8583.

of the urethra to the left corpus. To close over the roof of the urethra a continuous chromic catgut suture is used. Figure 966 shows how the newly formed urethra is shifted to its new position beneath the corpora cavernosa simply by the bringing together of the two corpora above it, using interrupted sutures of chromic catgut. The operation is then completed (Fig. 967) by a dorsal line of sutures, bringing together the two halves of the glans and approximating the skin edges along the dorsum of the penis. A careful study of the semidiagrammatic sectional views will give a clearer understanding of the various steps of the procedure, and of the relation of parts, than can be conveyed by any description. In order to divert the flow of urine, a perineal urethrotomy was done before the plastic operation was begun, and a retention catheter inserted. Perineal drainage was maintained for ten days.

This procedure is very simple and entirely satisfactory, and has the great merit of practically restoring the urethra to its normal location and producing an almost normal external

meatus. Although I was ignorant of Cantwell's work, the idea of transplantation of the new urethra is similar to his; but the plan of leaving the skin for the new urethra attached to one corpus cavernosum in order to secure adequate blood-supply, and then rotating this structure, is quite original, and in fact the most important part of the procedure. Thus, a successful operation is practically assured by the removal of the one great defect which has been found to occur after Cantwell's operation, namely, death or atrophy of the skin transplant due to imperfect blood-supply. The plastic on the glans is also entirely different.

This operation has been used quite successfully in 4 cases.

The Cure of Incontinence of Urine Associated with Epispadias.—Not infrequently the urethra above the epispadiac defect is greatly dilated. Examination will show that there is absence of musculature along the roof, and that the sphincteric structures in the membranous region, and at the vesical neck are not approximated in front, but are widely separated, as shown in Fig. 968.

In 1922 we presented a new radical operation for the cure of incontinence associated with epispadias. In this article[1] a careful review of the literature was made, and we were unable to find any male case cited in which by any procedure the incontinence of urine had been radically cured.

Radical Operation.—The plan of operation which has been carried out in 4 cases was to attack the defect, remove the roof of the prostatic and membranous urethræ, excise enough tissue on each side until satisfactory muscle was obtained, and the urethra sufficiently narrowed so that when the mucous membrane and muscular edges were drawn together a functionally tight vesical orifice and external sphincter around the membranous urethra would be artificially secured. At a second operation the epispadias was cured by the procedure previously described. We cannot better give the details of this complex procedure than to quote the records of the first case in which this was carried out.

Epispadias, complete incontinence of urine, radical cure.

B. U. I. 8583, V. W. C., eighteen years old, single. Admitted March 3, 1920.

Complaint: Deformity of penis and incontinence of urine.

Family history: Negative.

Patient was born with deformity of penis and incontinence of urine. At the age of fourteen he underwent an operation for epispadias which was entirely unsuccessful. Patient has never attempted sexual intercourse, although he has erections, during which the penis forms a curve which is so broad and flat that coitus would be physically impossible (apparently). No history of venereal disease. In recent years, owing to a constant leakage of urine and the resultant odor, the patient has had to quit school.

Examination: Patient is a strong, well-developed, healthy looking young man. Heart, lungs, and abdomen negative. Suprapubic regions negative.

Genitalia: Complete epispadias is present and the penis is directed upward and lies against the pubis. The scrotum is normal in size and testes, epididymes, and cords are normal. The penis is broad and along the dorsum there extends a fairly deep groove which represents the urethra. The roof of the urethra is absent for a distance of about 2 inches and beyond that is in the form of a deep funnel which extends down into the bulbous urethra; the corpora cavernosa are in apposition beneath, but are partially separated by the trough-like urethra. The urethral groove extends down through and almost completely divides the glans into two halves. The penis is short, broad, and curved upward on the pubis. The prepuce is divided and hangs as a redundant flap on the under surface of the glans on each side. The condition present is shown in the drawings (Figs. 968, 969). By drawing the penis out by the scrotal hood a deep funnel-like urethra is seen in front of the symphysis pubis and into this the finger can be inserted, showing a distinctly dilated external sphincter. Rectal: Anal sphincter is normal, prostate is smaller

[1] Young: Journal of Urology, 1922, vii, 1–32.

than normal, median furrow and notch wide and shallow. Each lateral lobe is approximately the size of the distal phalanx of the index-finger. The seminal vesicles are apparently normal and somewhat distended.

Cystoscopy.—The cystoscope enters easily, no stricture, no residual urine, bladder capacity 175 c.c.; tonicity good. When more than 175 c.c. of fluid entered the bladder the fluid escaped around the shaft of the instrument, showing a definitely dilated sphincter. The ligamentum interuretericum is concave and less developed than usual. The ureteral ridges are thin but fairly prominent; orifices apparently normal. The trigone is apparently less prominent than normal. The cystoscope can be drawn out into the posterior urethra and shows a dilated internal orifice, a verumontanum apparently larger than normal and on the left a fairly deep depression in front of the median portion of the prostate. Study of the prostatic orifice shows a dilated orifice and an absence of the usual sharply defined margin. The bladder mucosa is apparently normal. No cellules or diverticula. Study of the region of the external sphincter is not very satisfactory, but it is apparently somewhat dilated. Urethroscopy shows a definite dilatation of the internal

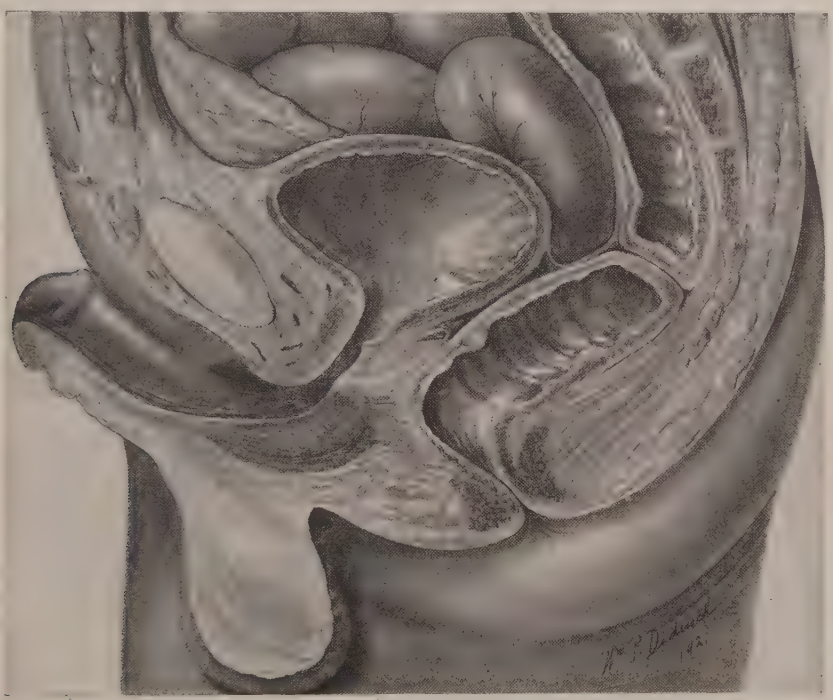


FIG. 969.—Operation for the cure of epispadias. Sectional view to show the dilated prostatic orifice (internal sphincter) and membranous urethra (external sphincter). B. U. I. 8583.

sphincter, which is wide open, and an imperfect closure of the external sphincter. *x*-Rays show a separation of more than 1 cm. of the symphysis pubis.

Preliminary study: The patient complains principally of incontinence which is present almost always night and day. An attempt was made to dilate the bladder and to try to teach the patient to control his urine by exercises; under this treatment the bladder was dilated from 175 to 230 c.c. and the patient seemed to gain some control, but it was, at best, imperfect and he frequently wet the bed at night and his clothes during the day time. Accordingly, it was decided to carry out an operation to relieve the condition.

Operation.—October 8, 1920: Young. Nitrous-oxid, oxygen, ether. Suprapubic cystotomy. Discovery of dilated internal sphincter. Excision of roof of urethra in prostatic and membranous portions. Plastic operation to restore a normal internal prostatic orifice and functionating internal and external sphincters.

An incision was made in the median line about 5 inches long (Fig. 970) and the bladder widely opened and an excellent view obtained. The prostatic orifice was widely open, as shown in

Fig. 970, *a*. The entire prostatic urethra was markedly dilated and there was no evidence of sphincteric action present, the tissues in front of the urethra were thin and fibrous. On each side and posteriorly there was muscle present. A finger inserted into the posterior urethra passed without difficulty out through the external sphincter and another finger, inserted through the epispadias into the bulbous urethra, easily met the finger which had been passed from the bladder outward, thus showing marked dilatation, not only of the prostatic urethra but of the membranous urethra and external sphincter. Investigation showed little or no "triangular ligament" and the complete absence of musculature in front of the urethra in the bulbomembranous region. The trigone was distinctly atrophic in appearance, but the ureteral orifices looked normal. The

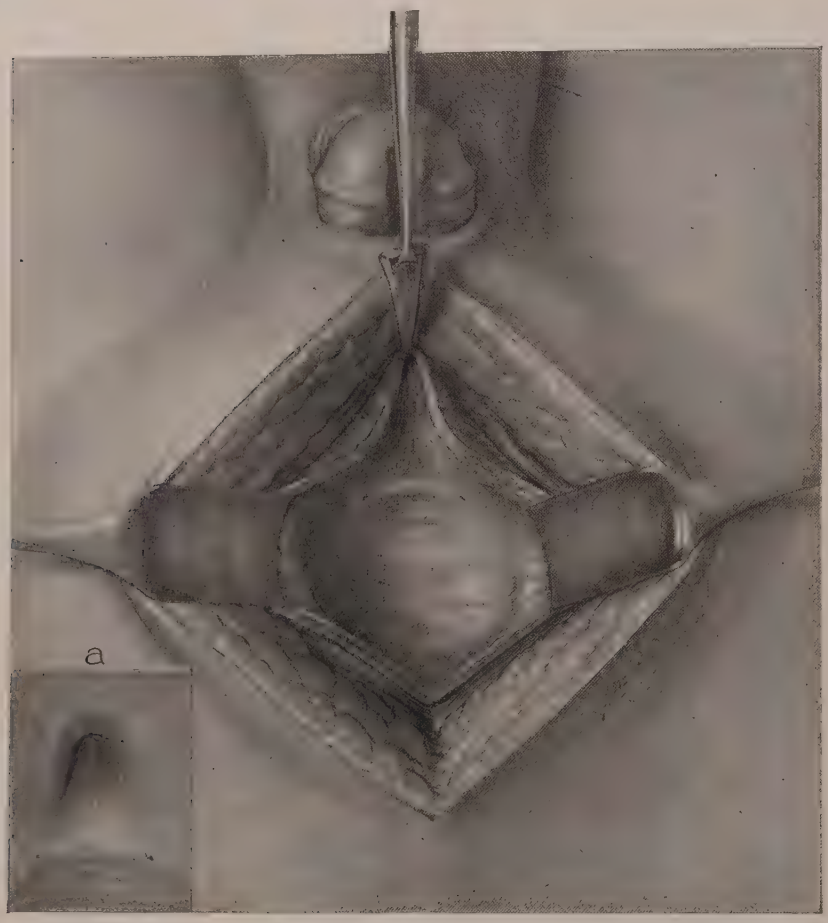


Fig. 970.—Young's operation for the cure of incontinence associated with epispadias. At *a* the dilated vesical orifice is shown. The trigone is atrophied. The cystotomy incision is extended into the urethra and the triangular piece removed from the anterior urethral wall of sufficient size so that when the urethra is reconstructed the caliber of the urethral orifice will be normal. B. U. I. 8583.

operator decided to confine his attention to curing the incontinence and thought it necessary to attack not only the internal sphincter and vesical orifice, but the external sphincter as well. Accordingly, the anterior wall of the prostatic urethra was excised, as shown in Fig. 970. The adjacent portion of the anterior wall of the bladder was also excised, so as to leave just sufficient tissue to form, when closed, a fairly normal prostatic urethra. Examination showed that there was muscle on each side which could be drawn together. There still remained the dilated external sphincter and it was found possible by inserting a narrow retractor to obtain a good view of the roof of the membranous urethra through the epispadiac defect and the dilated bulbous urethra. A clamp was then inserted, grasping the roof of the urethra, and with a delicate

knife the mucous membrane and adjacent tissues were excised along the roof of the membranous urethra (Fig. 971) until the region of excision, which had been carried out suprapubically, was reached. In this way the entire roof of the prostatic and membranous urethra had been excised. (In some later cases we have continued the anterior incision down into the epispadiac opening. See Chapter XVI, and the following case.) Through the suprapubic wound, by means of a continuous chromicized catgut suture which did not penetrate the mucous membrane, the prostatic urethra was closed, the muscle approximated at the vesical orifice and a tight internal sphincter produced. By a continuation of the same suture the adjacent anterior wall of the bladder was approximated (Fig. 972). The view obtained then in the bladder was that of a normally closed prostatic urethra, whereas previously there was a funnel-like neck which extended into the urethra.

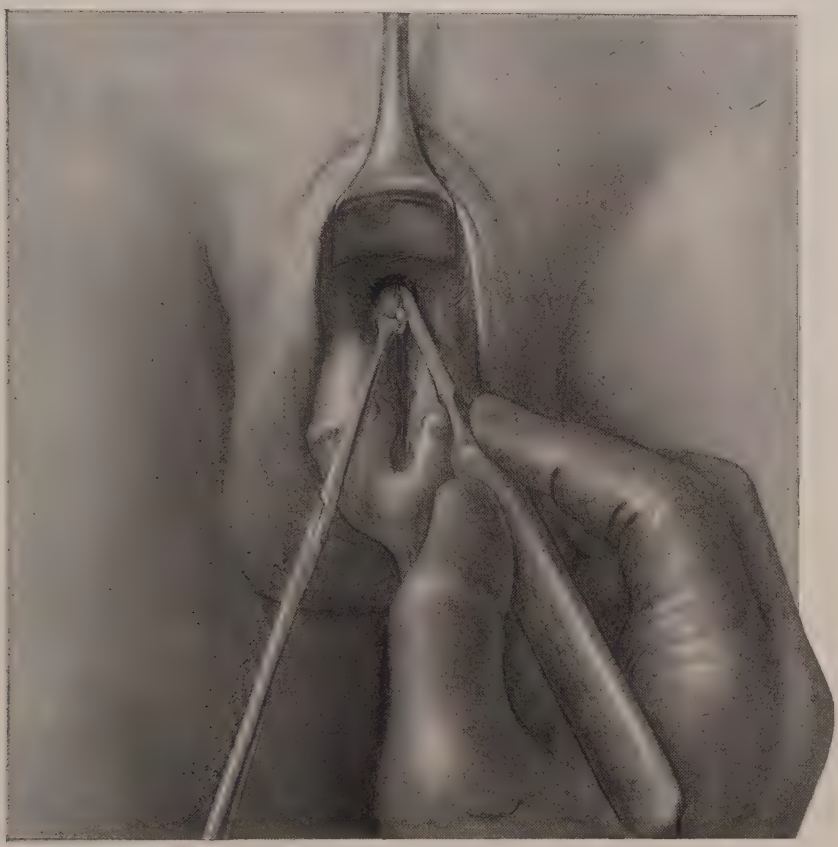


FIG. 971.—Operation for the cure of epispadias. The roof of membranous urethra is being excised through epispadiac cavity held open by retractor. B. U. I. 8583.

By means of the "boomerang needle-holder" a suture of chromicized catgut was placed in the roof of the membranous urethra through the epispadiac defect and the dilated posterior urethra, as shown in Fig. 973. Investigation showed that the membranous urethra was tightly approximated. The bladder was closed with a continuous chromicized catgut suture, leaving an opening at the upper angle for catheter drainage. The recti muscles and skin were drawn together with interrupted silver wire sutures with prevesical drain at the lower angle, suprapubic mushroom catheter drainage for the bladder. No operation to cure the epispadias was done at this time.

Convalescence.—October 12th: The patient has done well, suprapubic drainage satisfactory. One per cent. mercurochrome has been injected in small amounts daily into the bladder and bulbous urethra. No evidence of infection.

October 19th: The patient has done well; drains freely through suprapubic tube. Mercurochrome instillation daily.

October 23d: Suprapubic tube has been removed, but the patient voids through the penis and has partial control.

October 30th: Catheter replaced in suprapubic sinus and attached to Davis vacuum bottle.

December 7th: The patient has had an excellent convalescence. Suprapubic drainage is still maintained in view of proposed operation for epispadias. At times the patient has voided urine in fair amount through the urethra and has apparently complete control.

Operation.—December 8, 1920: Young. Nitrous-oxid, oxygen, ether. Plastic operation to repair and cure epispadias. The technic followed was similar to that previously described (Figs. 963–967). Incisions were made on each side so as to give abundant tissue for a large urethra. At the posterior angle the incision went down into the depths of the cavity toward the bulbous urethra and the skin on each side was elevated freely. At the glans penis the incis-

Fig. 972.—Operation for the cure of epispadias. Showing approximation of cut edges of prostate with boomerang needle-holder and resultant closure of prostatic orifice. *a*, Closure of prostate completed. *b*, Vesical orifice, internal sphincter, after suture. B. U. I. 8583.

ion on the left extended only a short distance on the anterior surface of the glans, the new urethra being left continuous with the skin of the glans. On the right side the incision was carried deeply through the substance of the glans to the inferior surface so as to bisect the glans and to place the new urethra in a normal position. The corpora cavernosa were widely separated by an incision to the right of the new skin reserved to form a new urethra and after this had been approximated by continuous chromicized catgut suture and reinforced by a second line of continuous sutures, the urethra was depressed between the corpora cavernosa, the left corpus being rotated with it, the two corpora then held in place above the new urethra by a continuous line of chromic catgut sutures. Another line of continuous sutures was placed to draw together the skin along the dorsum. The foreskin which had largely disappeared as a result of the skin plastic was drawn together with an additional continuous chromicized catgut stitch. The glans penis was approximated above the new meatus with interrupted stitches of chromicized catgut. At

the upper angle of the wound the tissues were not entirely approximated, a space being left for escape of serum.

Remark: At the end of the operation the penis looked quite normal, the glans was well formed and the tissues were approximated without tension. The suprapubic drainage was continued.

Convalescence.—December 11th: Patient had a chill, followed by a rise of temperature to 105° F. Examination showed slight edema of penis, but no definite infection was made out. December 13th: Patient has continued to have slight fever and pus can be expressed from the new formed meatus. Injections of a small amount of 1 per cent. mercurochrome have been carried out several times daily. December 18th.: The temperature has become normal and suppuration has ceased. The wound has not broken down and condition is excellent. December 28th: Suprapubic drainage has been entirely satisfactory. The plastic operation has healed everywhere

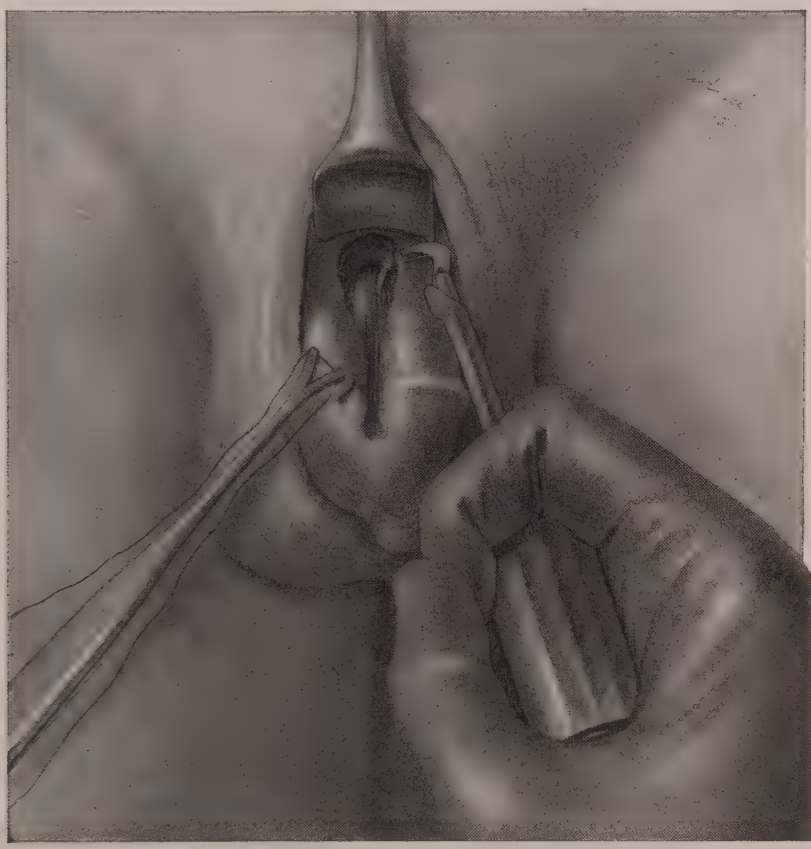


FIG. 973.—Operation for the cure of epispadias. Placing of sutures in roof of membranous urethra to tighten external sphincter with boomerang needle-holder. B. U. I. 8583.

except at the root of the penis where the tissues have not closed. The urethral suppuration has ceased. General condition excellent. January 10, 1921: Suprapubic drainage continued, occasionally patient is able to void through the new formed urethra and has good control. January 30th: Urine escapes from a small fistula at the base of the penis. Filiforms show a stricture or division of the urethra about 1 inch from the new meatus. After some difficulty filiforms and followers are passed and the urethra is well dilated. February 11th: Sounds again passed through the new urethra. Suprapubic sinus completely closed. Patient voids urine freely, good stream and has complete control. February 15th: Excellent condition maintained, further dilatation carried out. Patient able to void normally about every four hours. Fistula at base of penis almost healed. No 22 F. sound passed with ease. General condition excellent. Patient has complete urinary control. On erection the penis is straight, the upward curvature has practically disappeared. Patient is discharged.

May 17, 1921: Patient returns for observation. He is able to retain urine all night and for normal intervals during the day. He drinks water in considerable quantity and passes as much as 300 c.c. at a time. He has complete control and even when the desire to urinate is strong he is able to hold urine until he can walk to a convenient place to void. Desire, erections, and sexual powers are quite normal. Intercourse frequent and entirely satisfactory. Ejaculations apparently normal in every respect.

Examination: The condition present is shown in the accompanying drawing (Fig. 974). As seen here, the glans is normal in appearance with the exception of a small scar along the corona in the median line above. The prepuce is redundant on each side beneath the glans. The dorsum has been completely restored and the corpora cavernosa approximated in their proper position above the urethra, which lies along the inferior surface of the penis. The patient passes urine freely in large stream, has perfect control and urine is sterile. He states that the organ on erection is about 4 inches in length, of normal shape, and that coitus is normal and very satisfactory to both parties.

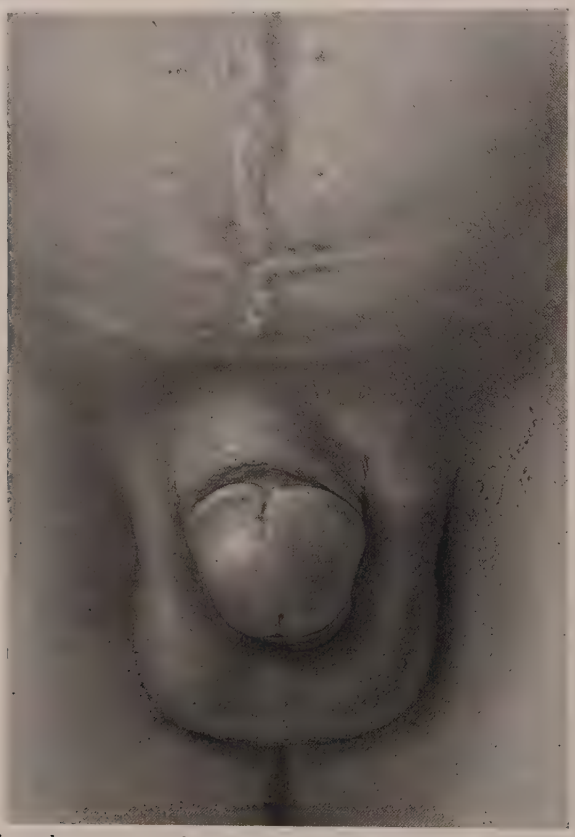


Fig. 974.—Final result seven months after plastic operation to cure epispadias with incontinence. Urethra has been transplanted to the inferior surface of penis. Patient has perfect urinary control, no fistula. Sexual powers normal. B. U. I. 8583.

Comment: The result obtained here is to be considered quite ideal and justifies us in feeling that at last a satisfactory procedure has been discovered for the complete cure of these severe deformities associated with the most distressing condition, incontinence of urine.

This and other cases of incontinence and their operative cure have been published in detail.

Epispadias is rare in the female and in only 1 case has an operation been carried out in this clinic for its cure. The result obtained in this case, however, is so remarkable that it is worthy of record here.

[1] Young, Journal of Urology, 1922, viii, 361–429.

Epispadias in female, incontinence of urine, radical cure by Young's operation.

B. U. I. 11,584. Female, aged five years, admitted May 1, 1923, with incontinence which had been present since birth. One operative attempt to cure incontinence had been made without success. Examination showed divided clitoris, definite epispadias, the urethra being widely dilated, and urine constantly leaking from it. Instruments passed into the bladder showed no sphincters. Bladder was small but otherwise negative. *x*-Ray examination showed that there was wide separation at the symphysis pubis. The recti muscles were separated, there being a broad triangular area of fascia which connected them. No ventral hernia present.

May 4, 1923: Operation, Young; plastic to cure congenital defect of anterior urethra and incontinence of urine associated with epispadias. The operation is shown so graphically in the accompanying illustrations (Figs. 975–980) that further description is scarcely necessary. The

FIG. 975.—Girl five years old with epispadias, incontinence, wide separation of pubic bones and recti muscles. Median incision. B. U. I. 11,584.

median line incision started from a point just below the umbilicus and extended to the external urinary meatus (Fig. 975). It was found necessary to divide the ligamentous tissue connecting the symphysis pubis and to open the bladder and urethra widely, as shown in Fig. 976. Inspection then revealed normal trigone and urethra, somewhat contracted and inflamed bladder, normal ureteral orifices, dilated posterior urethra, the vesical orifice being at least 2 cm. in diameter and with no evidence of sphincter. Running externally from a central elevated ridge, which probably represented the uvula vesicæ, was a ridge of muscle on each side which probably corresponded to the lateral sphincteric muscles described by Young and Wesson. The roof of the urethra was almost entirely fibrous, and it was evident that both external and internal sphincters failed to coalesce anteriorly. In order to make a tight vesical orifice it was necessary to excise a large amount of mucous membrane, fibrous tissue, and muscle from each side, as shown

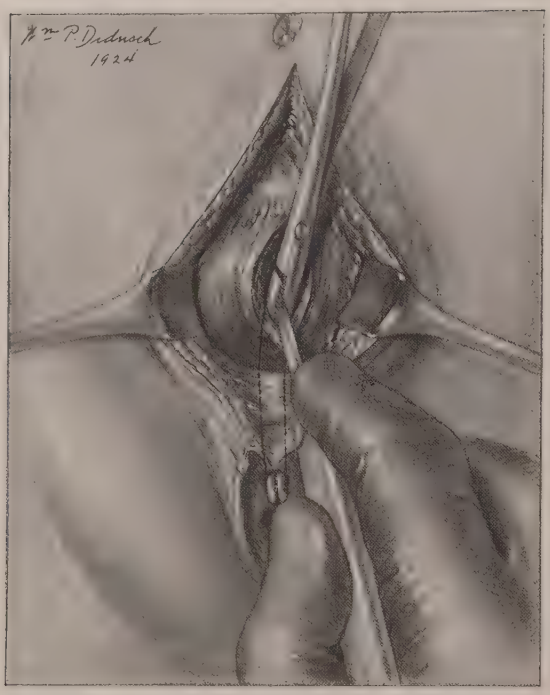


FIG. 976.—Girl with epispadias and incontinence of urine.' Bladder opened suprapubically in median line. Clamp passed out through urethra which is being divided anteriorly by scalpel previous to plastic on vesical neck. B. U. I. 11,584.

FIG. 977.—Young's operation in a case of epispadias with incontinence in girl of five years. The bladder and urethra have been opened. The lateral muscles of internal sphincter are seen running outward in the wall of the dilated vesical orifice. With scissors the redundant portions of vesical neck are being excised preparatory to plastic to tighten orifice. B. U. I. 11,584.

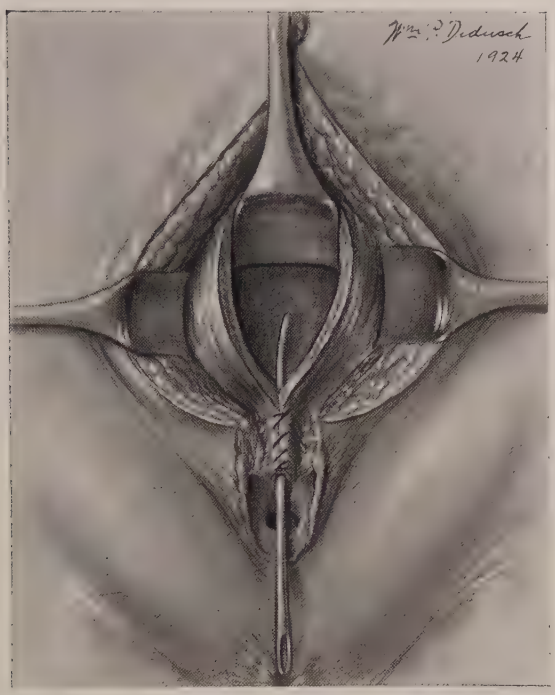


FIG. 978.—Epispadias with incontinence in girl of five years. Vesical neck and urethra tightened by sutures after resection of redundant tissues of anterior and lateral walls. B. U. I. 11,584.

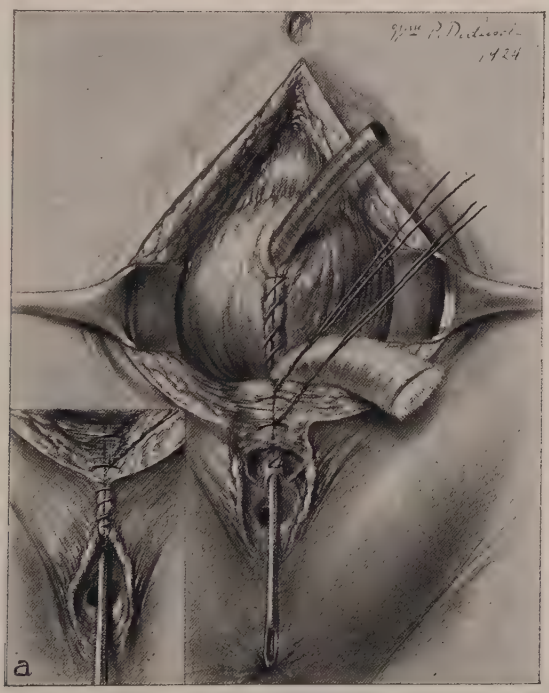


FIG. 979.—Young's operation for epispadias and incontinence in girl of five years. The bladder is closed with drainage at upper end. Pubic bones approximated with heavy silver wire in front of new formed urethra. *a*, Final plastic around urethra approximating muscles of external sphincter. Silver probe in urethra to maintain lumen. B. U. I. 11,584.

in Fig. 977. This excision was continued down to the end of the urethra so that the amount of mucous membrane was greatly reduced and satisfactory muscle tissue obtained on each side. The urethra was then approximated from each side by means of a continuous chromic catgut suture, as shown in Fig. 978. A small silver probe was left within the urethra during and after this procedure. The bladder was then closed anteriorly, as shown in Fig. 979, leaving a small opening at the upper end for drainage. The ligamentous tissues connecting the pubic bones were then drawn together with two heavy sutures of silver wire, effort being made to approximate bony structures without complete success. Skin and subcutaneous structures were then brought together in front of the urethra and the two halves of the clitoris, the inner surfaces of which had been denuded, were approximated (Fig. 980), the abdominal muscles, fascia, and skin were then brought together with heavy sutures of silver wire and intervening clips of metal. Suprapubic drainage with tube and gauze was provided and the silver probe left in place. This operation produced a very tight urethra which firmly gripped the silver probe.

Fig. 980.—Epispadias and incontinence in girl of five years. Final closure. Silver probe in urethra. Pubic bones brought together with heavy silver wire (shown in rubber tubes). Tube and cigarette drains immediately above these. Recti muscles and skin approximated with silver wire sutures and metal clips. Result obtained in this case was perfect control and normal urination followed in one and a half years. B. U. I. 11,584.

June 1, 1923, now twenty-eight days since operation: Suprapubic wound seems to have healed completely. The silver wires approximating the pubis are still in place. The labia do not close in front, but otherwise are quite normal. Patient is voiding urine at intervals. June 15th: Wire sutures removed. Suprapubic urinary fistula still present. It is impossible to find the external urethral opening, either on inspection or with filiforms or probes. A small sound is then passed through the suprapubic fistula into the bladder and out through the urethra. After this a filiform and followers up to No. 18 F. were passed without much difficulty into the bladder. There is apparently no stricture. A small catheter was also passed through the urethra into the bladder and bladder capacity found to be 40 c.c. Suprapubic fistula curetted. June 29, 1923: Suprapubic fistula is healing. Epispadias completely cured. Patient has excellent control and retains urine for four hours. Voids voluntarily with good stream. *x*-Ray still shows wide separation of symphysis. Nevertheless, the operative result is excellent. Patient discharged. November 5, 1923 (letter): Patient is able to retain urine two or three hours and to control desire until she arrives at a toilet. Urination normal.

Results.—We have now had 4 cases of incontinence associated with epispadias, 3 male and 1 female. The first male case and the only female case have been described at length. The postoperative treatment is fully given in these 2 cases. In the other 2 cases the treatment was the same and the results obtained equally brilliant. The problem of curing epispadias without and with incontinence seems to have been completely solved by the operative methods which have been presented here.

CHAPTER XXI

OPERATIONS ON THE PENIS

CIRCUMCISION

Also called ablation of the prepuce or posthectomy. This is the oldest plastic operation in surgery, harking back to prebiblical days. It is possible that its wide-spread use as a religious rite came from the fact that circumcision was a potent factor in preventing the acquiring of syphilis and other diseases of the penis, urethra, glans, and prepuce. At any rate, it has been done in all parts of the world and by the most distantly separated peoples. A certain sacrificial import has usually been connected with the rite, although the exact nature of the original conception is not known to anthropologists. In general, the religious operation is performed either within a few days of birth, as among the Jews, or upon reaching a marriageable age, as among the South Sea Islanders, Mohammedans, etc. In the former case it has become a purely religious ceremony, while in the latter it has an element of preparation for the functions of matrimony. Some of the tribes who circumcise late also perform a similar operation on the female, a freeing of the clitoris.

Indications.—Phimosis is usually the principal indication for non-religious circumcision. There are numerous complications which also occur, such as retained secretion, balanoposthitis, calculi of the preputial cavity, herpes, benign or specific ulcers, papillomata, etc.

Anesthesia.—In young children a light general anesthesia is usually preferable, and the operation may be done at any age—preferably during the first year of life. Local anesthesia is quite satisfactory and the injections may be made in the line of the operation or along the base of the penis by the principles of "block anesthesia." Using a 2 per cent. procain, a circle of injections is made along the base of the penis in the subcutaneous tissues. About 1 c.c. of the solution is also injected beneath Buck's fascia on each side. As a rule, complete anesthesia of the entire surface back of the corona should be obtained. If the prepuce cannot be retracted, it may be desirable to make several punctures so as to reach the inner surface of the prepuce before making the first incision.

The Operation.—Common Method.—The prepuce is caught by two clamps, front and back, and drawn downward. A long slender clamp is then placed obliquely across the prepuce, the line of the clamp being parallel to the corona and care being taken not to include the glans penis. The distal portion of the prepuce is then cut off with scissors or knife external to the clamp, which is then removed. The skin promptly retracts, usually leaving the hood of the inner preputial surface tightly covering the glans. When the skin retracts numerous bleeding points will be discovered and should be carefully ligatured with fine plain catgut. The inner surface of the prepuce is then split up in the median dorsal line to within 1 cm. of the coronal sulcus, as shown in Fig. 981. The corners of each flap are then caught with forceps and put on tension while the operator excises with scissors the redundant tissues along a line parallel to the coronal sulcus and 1 cm. distant from it

(Fig. 981, *b*). This leaves the frenum 1 cm. in length. Bleeding points are again taken up and carefully ligated. The wound is closed with interrupted sutures of catgut. By leaving these long, a slender strip of medicated gauze may be fastened so as to cover the line of incision by simply tying the long ends of the ligatures around the gauze. In the case of young children it is usually better not to dress with gauze, but simply to apply a medicated ointment.

Subsequent Treatment.—The patient should be instructed to avoid wetting the bandage with urine and to apply a simple handkerchief or surgical dressing to cover the penis to prevent soiling from the outside. In the case of young men it is often advisable to give fairly large doses of bromids to prevent erections and

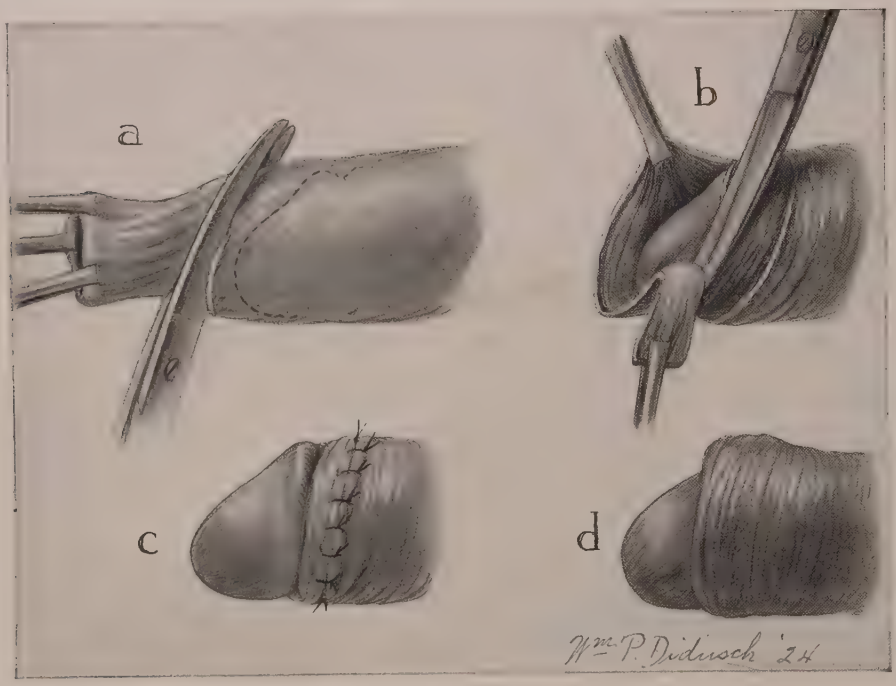


FIG. 981.—Operation of circumcision: *a*, Foreskin drawn down, excision of redundant skin with scissors. It is usually best to put on a long clamp above point of excision to avoid injury to glans. *b*, Excision of redundant inner layer of foreskin. *c*, Closure with interrupted stitches. *d*, Result, showing partial covering of glans when too much skin is not excised.

consequent pain and breaking of stitches. In difficult cases, ice-packs may be used for the same purpose.

SECOND METHOD.—The prepuce, if tight, is caught in front and back with a clamp, or with four clamps, if the orifice is fairly large. Traction is made and with a knife an incision is made parallel and 2 cm. external to the rim of the corona. This passes through skin and subcutaneous fascia. Blood-vessels encountered are clamped and the skin well retracted. The long hood of the inner surface of the prepuce is then divided longitudinally and excised parallel to the coronal sulcus, as previously described.

In performing the operation of circumcision the surgeon should decide beforehand whether he wishes to obtain a result in which the entire glans will be permanently uncovered or to have a definite preputial covering for a portion of the corona somewhat approximating the normal. The latter can be obtained if the

surgeon is careful not to excise too much skin and to leave a sufficient collar of mucous membrane around the corona. In carrying out the latter procedure care must be taken that no constriction remains and that an easily retractable prepuce is obtained. The advantage of the conservative operation is that the normal sensitiveness and lubricating secretions of the preputial skin are retained, both of which are said to be much appreciated later in life.

DORSAL INCISION

Indications.—This procedure is indicated where, in the presence of inflammation, ulceration, tumor, etc., the plastic operation of circumcision is contraindicated. If, for example, the wound of circumcision becomes infected with chancroidal virus, a fearful circular ulcer may result. Where the prepuce cannot be retracted for the treatment of infections, etc., a dorsal incision is carried out under anesthesia, as previously described.

Operation.—If possible to insert a grooved director into the preputial cavity, one may cut down upon this, carrying the incision up along the dorsum as far as the coronal sulcus. One may also simply incise with a knife through skin and subcutaneous tissues, being careful not to injure the glans. The two halves of the divided prepuce are then drawn out widely and retracted so as to obtain a good exposure of the glans and coronal sulcus for any treatment that may be indicated. If possible, the line of incision should be kept free from infection and if the tissues are healthy it may even be possible to approximate the wound surfaces on each side loosely with catgut sutures. The lesion found within the preputial cavity should be treated according to conditions present—excision of papillomata, cauterization of ulcers, etc. If, on careful examination, the ulcer appears malignant it may be necessary to obtain a section for diagnosis. In making the dorsal incision care should be taken not to cut into tumors or ulcers and to be prepared to carry out a radical operation in case malignant disease is discovered. The postoperative treatment includes adequate antiseptic applications.

OPERATIONS FOR PARAPHIMOSIS

This condition usually results from a phimosis which has been forcibly retracted behind the glans and remains there to produce constriction, edema, etc. In other cases it has resulted from inflammation in a normally retracted prepuce. Treatment is necessary to relieve the constriction and thus avoid possible gangrene.

Reduction can generally be accomplished by the following maneuvers: The constricting ring should be pulled back as far as possible. The edematous tissues below this are then forcibly compressed by gently squeezing upon them for several minutes, and the fluid can usually be forced out of them and pushed up the shaft of the penis. The flabby tissues can then usually be drawn down over the head of the penis by a method which Keyes describes as follows:

> Squeeze the penis behind the strictured prepuce in the fork of the index and middle fingers of both hands, one placed on each side. Now make pressure with the thumbs on both sides in such a direction as to compress the glans laterally rather than from before backward, and at the same time pull the strictured portion of the prepuce forward, the effort being rather to pull the stricture over the glans than to push the glans through the stricture. If these methods fail, operation must be resorted to.

Operation.—Incision is made in the depths of the constricting ring, which is above the swollen edematous mass of skin and subcutaneous tissues. The incision is made dorsally and longitudinally through subcutaneous tissues, until the con-

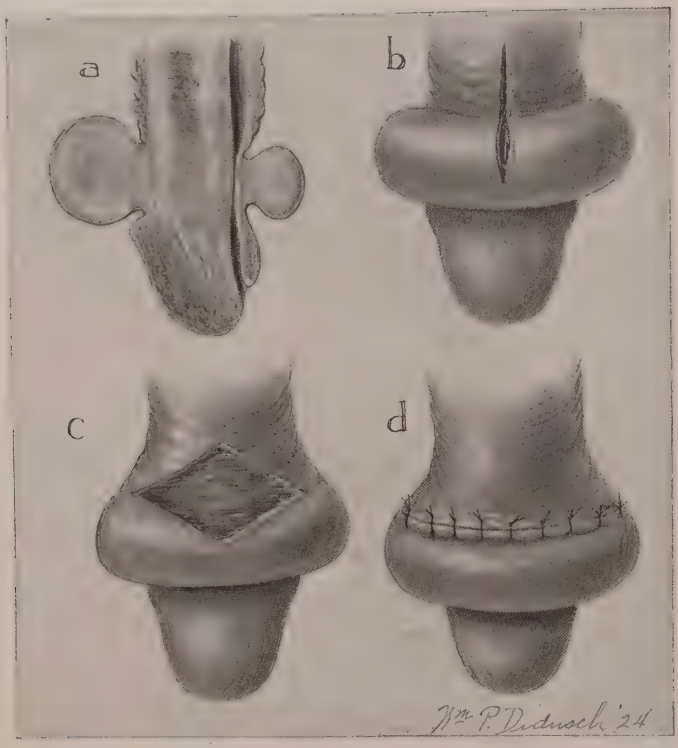


Fig. 982.—Operation for paraphimosis: *a*, Longitudinal section showing point of constriction above swelling. *b*, Longitudinal incision for division of constricting band (phimosis). *c*, and *d*, Heinecke-Mikulicz procedure to eradicate constricting band. Edema disappears later.

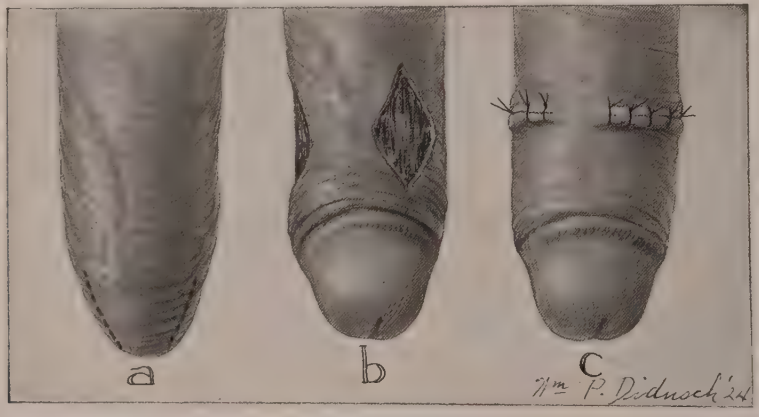


Fig. 983.—Operation for phimosis: *a*, Three incisions through constriction of foreskin, which was then retracted (*b*). Incisions then closed by Heinecke-Mikulicz principle (*c*), thus enlarging orifice and retracting foreskin. The result is a circumcision without excision.

striction is relieved and the prepuce may be drawn down over the glans (Fig. 981). An incision an inch long will usually be made and had best be closed according to Heinecke's principle transversely. This will have the effect of a

groove, enlarging the preputial orifice and preventing future paraphimosis. In some cases we have carried out Heinecke's principle also in phimosis on each side at the preputial margin, thus having three points in which the margin was excised and widened (Fig. 983). The effect of this is to retract the foreskin to the extent of the incision. As a matter of fact, the results of a circumcision can be thus obtained without the excision of any skin (posthioplasty).

OPERATION FOR INDURATION OF THE DORSAL FIBERS OF THE PENIS

This condition, which is variously known as induration of the corpora cavernosa, fibrous cavernositis, circumscribed fibrosis, plastic induration, etc., was first described by La Peyronie in 1743. Owing to the fibrous chordee which it usually produces, it has also been called "strabismus of the penis" and "squint of the cock" and treatment is usually demanded on account of the curvature produced and the resultant difficulty of coitus, though occasionally pain may be pronounced.

The situation of the induration is relatively superficial and generally occupies the dorsal portion of the septum between the corpora cavernosa and the adjacent tunics of the corpora, but is never in the erectile tissue. The etiology is unknown.

Treatment has, in our hands, been very unsatisfactory. Internal medication with iodids and other drugs in an attempt to cause an absorption has been entirely valueless. Likewise, the external application of radium and *x*-ray has given no results, and the implantation of emanation "seeds" has only increased the fibrosis.

Operation.—In several cases we have carried out an operation to excise the fibrous cord. Through a longitudinal incision little difficulty was encountered in excising a long fibrous mass which ran along the dorsum of the penis and extended a short distance into the septum between the two bodies without opening the cavernous tissue. It was even possible to preserve one or more of the dorsal blood-vessels which were not bound up in the fibrotic mass, which in section varied from a few millimeters to almost a centimeter in diameter. After the removal of the mass, the wound between the corpora cavernosa was easily approximated with continuous catgut suture so as to close the defect and approximate their fibrous sheaths.

Results.—The result of this operation which has been carried out in 3 cases has, however, been quite unsatisfactory, principally because of imperfect erection of which the patients afterward complained and a recurrence of the chordee. Review of cases in the literature shows that similar results have been obtained by other operators who have likewise carried out resection of the fibrous cord.

In the only case in which we have really succeeded by operative means the following technic was used:

A Plastic Operation for Dorsal Fibrosis of the Penis.—Median incision through skin and subcutaneous tissue. Careful preservation of blood-vessels. Isolation of anterior attachment of fibrous cord and careful dissection from the corpora cavernosa, starting at the terminal portion at or near the glans and gradually working backward by blunt dissection as much as possible, carefully avoiding injury to the cavernous tissue of the corpora and to the blood-vessels. This process was continued backward until about the midpoint of the penis was reached, the fibrous cord was then elevated well, the shaft of the penis was approximated beneath it and the end of the fibrous cord sutured to the dorsal skin of the penis which was then closed with catgut. The object of the operation was to free the anterior half of the cicatricial chordee, to close the

tissues tightly behind so as to avoid recurrence, and to fasten the end of the fibrous cord to the skin where contraction would cause no inconvenience.

In this case the patient had no impairment of erections, intercourse was satisfactory, and there was no recurrence of the chordee, as reported several years later.

We have had no operations upon cases of osteoma, enchondroma, or calcification of the corpora cavernosa, but a few cases have been reported in the literature.

OPERATION FOR DEFECTS OF THE CORPORA

We have carried out an operation in 1 case in which a considerable portion of the corpora cavernosa on each side had been destroyed in a previous surgical operation for hypospadias. In this case there was a terminal 1 inch in which the corpora cavernosa were normal in size and completely filled during erection. Back of this point, the corpora could not be palpated and there was no filling on erection for a distance of about an inch. Behind this point (it was at the penoscrotal juncture) the corpora cavernosa were normal. Erection was complete behind and in front of the defect, but on account of the defect the penis was flabby and intercourse impossible.

Operation.—The following operation was carried out with the object of approximating the terminal portions of the corpora cavernosa with the posterior portion and thus to obtain a shortened but fairly erect organ for coitus. The intervening fibrous tissue was excised. The ends of the corpora, in front and behind the deficiency, were freshened and then drawn together with mattress-sutures, placed in the tunics of the corpora on each side. The penis was thus much shortened, but the united (though shortened) corpora now formed a continuous organ, which on erection would be, we hoped, continuously rigid. The result obtained, as reported one year later, is as follows: For a time the external portion would remain flabby when the proximal portion became erect. Now both become firm and the gap between the two is smaller, and sexual intercourse much more satisfactory.

OPERATIONS FOR MALIGNANT DISEASE OF THE PENIS

Indications.—The indications are carcinoma and sarcoma. The operative technic will depend greatly upon the condition present. In case of early epithelioma, if the condition is confined to the prepuce, it may sometimes be radically excised by circumcision or by thorough cauterization. Unless the case is extremely early and without definite induration the inguinal glands should be extirpated. *x*-Ray and radium—both surface and interstitial applications—have been strangely ineffective in cancer of the penis, and at present operation is practically the only hope. If the disease upon the glans penis is at all extensive, a radical operation should be carried out.

Operation.—The technic which we prefer and which we have followed now in 28 cases is based on a complete removal of the line of lymph invasion as far as possible. This includes the glands of both groins, the intervening lymphatics, and an extirpation of the penis. The technic is as follows: The region of the tumor is very carefully covered with a tight antiseptic dressing, after which the region of the operation is again very thoroughly disinfected. This sterilizing process should be very complete, as one of the most serious postoperative complications is wide-

spread infection and breaking down of the wound. Unless the carcinoma extends a very considerable distance along the shaft of the penis, it is usually safe to amputate near the base of the penis (suspensory ligament) and not to excise the deeper portions of the corpora cavernosa and the bulb. The skin incision is shown in Fig. 984. As seen here, it extends from one anterior-superior spine to the other—a long curved line which sweeps downward to within 2 cm. of the base of the penis. Two longitudinal incisions are made (on each side of the front of the penis) to the point of amputation of skin, which should be somewhat redundant to cover well the ends of the corpora.

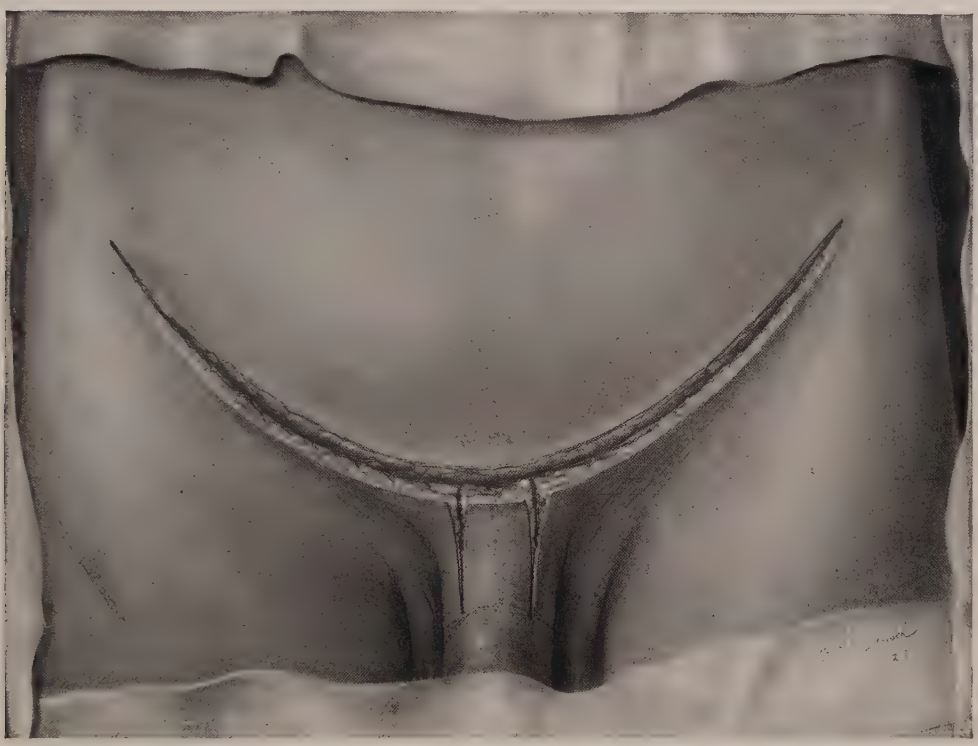


FIG. 984.—Incision for radical operation for carcinoma of penis and glands of groin, to be removed in one continuous mass. B. U. I. 8530.

With the operator and assistant working at the two upper angles of the wound, the skin is elevated (Fig. 985), the subcutaneous fat and glands are dissected cleanly from the deep fascia (Fig. 986). The spermatic cords must be thoroughly cleaned, as there is occasionally a small node at this point. When the region of the femoral vessels is reached the dissection should extend down the thigh so as to get the glands in that region and should also be carried into the upper part of the scrotum. The saphenous and superficial epigastric veins should be sacrificed, the cribiform fascia incised, and the deep group of femoral nodes dissected away cleanly from the artery and vein. This is necessary because, as shown in Chapter VIII, Vol. I, page 708, some lymphatic channels from the glans run directly to the deep group of lymph-nodes. The fat and lymph-glands in the pubic region are also freed from the deep structures and the dissection carried

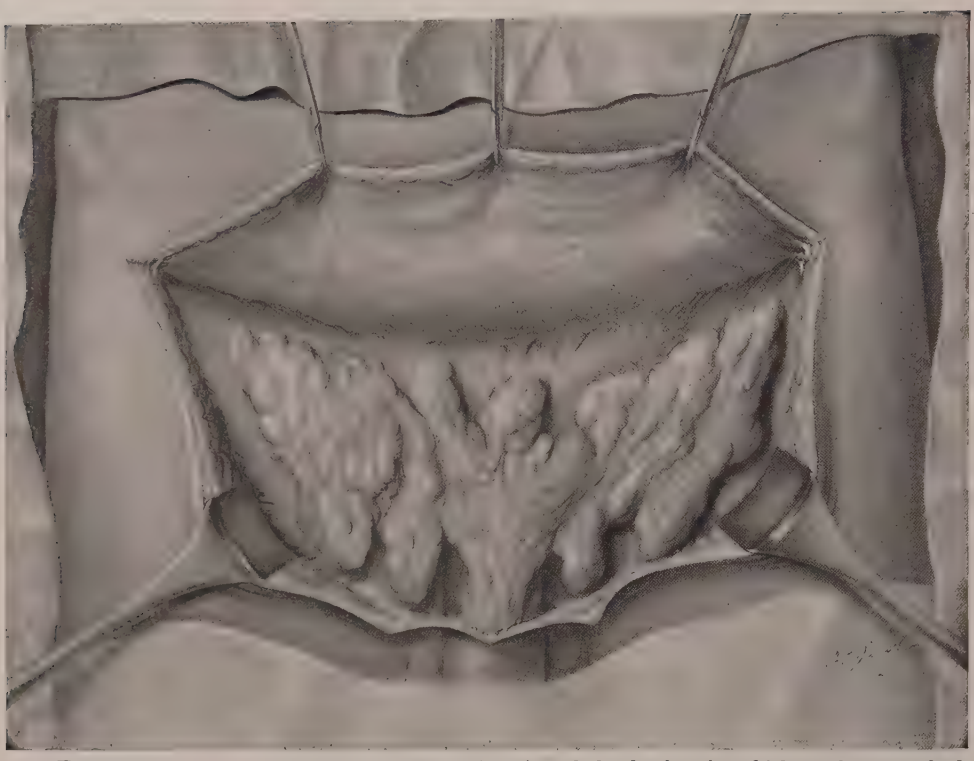


FIG. 985.—Radical operation for carcinoma of penis and glands of groin, which are first attacked by an operator on each side, the dissection being carried downward and inward toward the penis. B. U. I. 8530.

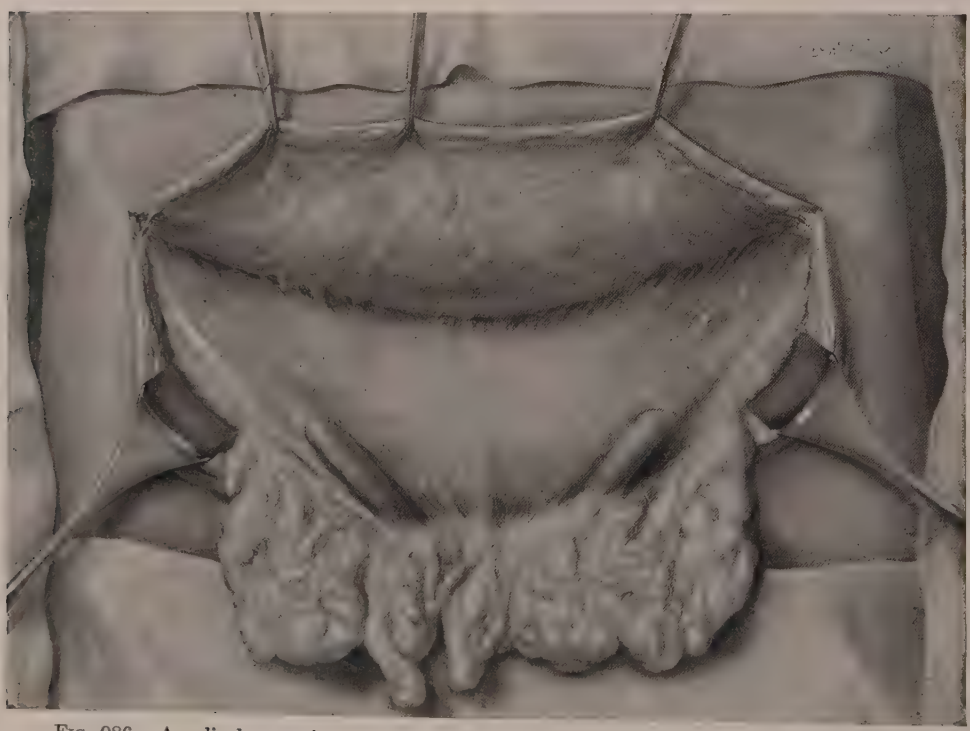


FIG. 986.—A radical operation for carcinoma of penis with removal, in continuity, of lymphatic channels to groins. Dissection of upper portion of groins and suprapubic region completed, exposing spermatic cords. B. U. I. 8530.

downward until the base of the penis is reached (Fig. 987). At this point the suspensory ligament is divided and the dorsal and lateral tissues dissected cleanly

FIG. 987.—A radical operation for carcinoma of penis. Dissection of glands, lymphatics, and fat in one piece completed. Division of penis near root. *a*, Showing closure of corpora cavernosa and urethra left ½ inch longer. Tourniquet about penis. B. U. I. 8530.

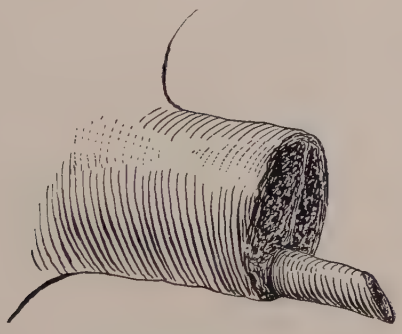


FIG. 988.—A radical operation for carcinoma of penis. The corpora are divided transversely 1.5 cm. behind oblique section of urethra. B. U. I. 8530.

from the corpora cavernosa from above downward until the point of division of the corpora is reached. It is well to divide these transversely on a level with the

FIG. 989.—A radical operation for carcinoma of penis. Operative specimen removed, showing penis and lymph-bearing area removed in one block.

FIG. 990.—Under surface of penis showing carcinoma, transverse section of penis 3 cm. above tumor. The continuous line of lymphatics and fat leading to prepubic fat above is shown. B. U. I. 8530.

symphysis pubis leaving a small stump, a tourniquet being applied about it to prevent hemorrhage. The dissection is continued downward until the urethra has been freed for a distance of about 2 cm. further than the corpora (Fig. 988). It is then divided transversely at least 2 cm. away from the nearest palpable tumor mass and the entire block, consisting of penile tumor, shaft and skin of penis, line of lymphatics, and fatty tissue and glands of both groins, is removed in one piece, as shown in Fig. 989.

Any arteries and veins that may be seen in the tissue should be clamped and ligated. The corpora cavernosa are then drawn together by approximating the sheaths from each side with interrupted or mattress-sutures, as shown in Fig. 987, *a*.

FIG. 991.—A radical operation for carcinoma of penis and glands in groin. Final closure with drainage. B. U. I. 8530.

This will usually control the hemorrhage. The skin is then closed after dividing the urethra obliquely or with a dorsal incision, so as to prevent stricture of the meatus, as shown in Fig. 991.

With this operation one obtains a thoroughly radical extirpation of the tumor and its line of lymph invasion. We believe very little is to be gained by extirpating the corpora cavernosa or bulb, as the lymphatics do not extend in that direction. Cunningham has shown, however, beautiful results by an operation in which the corpora and bulb were removed and a perineal urinary fistula produced. Allesandri and others have strongly advocated a "complete emasculation" with amputation of the penis and double castration, but, in our experience, patients object seriously to such mutilation and since some of them are able to have fairly

satisfactory coitus after even very extensive resection of the penis, as above described, we believe that the testes should be preserved. The line of lymph invasion does not lead into the retroperitoneal region and, therefore, abdominal extirpation of glands, such as is carried out for tumor of the testicle, is not indicated. In many details the technic above described is new.

Results.—The results obtained in our hands by the block dissection, above described, are given in Chapter VIII, Vol. I, page 720.

We are convinced that the operation herein described is sufficiently radical, that removal of testes should be avoided, and that nothing is to be gained by transplantation of the urethra into the perineum. Our cases have had good functioning results, could usually void urine in a satisfactory stream, and in many cases enjoyed sexual intercourse, the ejaculation being quite satisfying.

CHAPTER XXII

UROLOGY IN INFANCY AND CHILDHOOD

INCREASING interest has recently been aroused in urologic problems of infancy and childhood by a number of important articles, and it seems wise to devote a special chapter to this subject. The diseases encountered are much the same as those seen in adults, but the clinical and mechanical problems are often quite different, and the instruments required are generally of special caliber and design.

The following list of the urologic cases admitted to the Harriet Lane Home, was obtained through the courtesy of Dr. John T. Howland, professor of pediatrics in the Johns Hopkins Medical School:

TABLE 187

UROLOGIC DISEASES IN CHILDREN

	Total number of cases.	Number of boys.	Number of girls.	Deaths.	
				Boys.	Girls.
Pyelonephritis	376	55	321	17	34
Pyonephrosis	2	2	...	1	
Pyelocystitis	151	24	127	7	8
Infarct of kidney	3	...	...	..	2
Perinephric abscess	5	...	...	..	1
Tuberculosis (sex not stated, 5)	9	3	1	..	1
Renal calculus	2 (not admitted)				
Hydronephrosis	13	12	1	7	
Movable kidney	2				
Prolapse of kidney	4	...	...	..	1
Polycystic kidney	4	...	...	..	2
Horseshoe kidney	2	...	...	..	2
Hypoplasia of kidney (congenital)	2	...	...	..	2
Absence of kidney (congenital)	1	...	...	..	1
Stricture of ureter	4 (age: 5 months, 1 year, 8 months, 1 day, 8 months)				
Calculus, ureteral	1				
Enuresis	789	454	335		
Hypertrophy of bladder	5				
Extrophy of bladder	2				
Diverticulum of bladder	1	1			
Vesical calculus	1				
Cyst of urachus	1	...	...	..	1
Stricture of urethra	11	10	1		
Gonorrheal urethritis	3 (age: 4, 6, 7 years)				
Non-specific urethritis	16	13	3		
Hypospadias	41				
Undescended testicle	53 (unilateral)				
" "	14 (bilateral)				
"Sarcoma" of testicle	1	1 (age 4 months)			
Teratoma of testicle	1	1 (age 30 months)			

In 259 cases in which we have studied the ages of the patients, the records show as follows:

TABLE 188

Ages.	Number of cases.
6 months	1
7 months	1
1 year	0
2 years	18
3 years	14
4 years	34
5 years	41
6 years	35
7 years	37
8 years	32
9 years	31
10 years	21
11 years	18
12 years	15
13 years	9
14 years	1
19 years	1

In a series of 4903 autopsies in children, Bugbee and Wollstein[1] report the following malformations of the kidney. In this series there are 24 malformations in other parts of the body, including 2 spina bifida, 1 double club-foot, 1 exstrophy of the bladder with epispadias, and 1 hypospadias. Their findings were as follows:

TABLE 189

MALFORMATIONS OF KIDNEY ENCOUNTERED IN AUTOPSIES ON CHILDREN

Single kidney		1
Double kidney		3
Double ureter		1
Renal displacement		6
(*a*) No lesion (2 pelvic)	4	
(*b*) With cleft ureter	1	
(*c*) Movable or floating	1	
Rudimentary kidney		5
(*a*) Not cystic	1	
(*b*) Cystic	4	
Polycystic kidney		15
Monocystic kidney		2
Cystic kidney with hydronephrosis		3
Horseshoe kidney (1 sigmoid)		10
Nephrolithiasis		13
(*a*) No pelvic dilatation	10	
(*b*) With pelvic dilatation	3	
Pyonephrosis		9
(*a*) Single	3	
(*b*) Double	6	
Hydronephrosis		44
(*a*) Single	19	
(*b*) Double	25	
Total number of cases		117
Male		82
Female		35

[1] Journal of the American Medical Association, December 13, 1924, lxxxiii.

In a report of 60 cases of various urologic conditions in children, Kretschmer[1] states that pyuria was present in 30 cases and hematuria in 18. The diagnoses were: Pyelitis 28, pyelonephritis 4, hydronephrosis 4, renal tuberculosis 4, sarcoma of kidney 2, nephrolithiasis 1, acute hemorrhagic nephritis 1, hydro-ureter 1, ureteral stricture 1, bladder calculus 4, cystitis 5, enuresis 2, angioma 1, gonorrheal cystitis 1, trigonitis 1, diverticulum 1, pyuria 1, spina bifida 1, congenital valve of the posterior urethra 1, no diagnosis 1. Bacteriologic study showed the infecting agent to be Bacillus coli 25 cases, staphylococcus 5, tubercle bacillus 4, paratyphoid 1, gonococcus 1.

Hyman[2] gives some interesting statistics. In 38 cases reported by him the diagnoses were as follows: Perinephric abscess 4, renal tuberculosis 3, renal calculus 2, ureteral calculus 1, vesical calculus 1, tumor of kidney 2, sarcoma of kidney 2, pyelonephritis 3, hydronephrosis 2, suppurative nephritis 1, subacute nephritis 1, bladder diverticulum 1, chronic vesical retention of urine 12, nephroptosis 1, perinephritis 1, contusion of kidney 1.

Hyman states that he has records of more than thirty children under nine years of age who have been cystoscoped during the past few years. The youngest patient was a boy of seventeen months who was subsequently operated on for a kidney tumor. The youngest boy catheterized was under two years old—the youngest girl twenty-two months of age.

Urologic Examinations in Infants and Children.—Instruments of considerable size can be passed into the bladder in females, even in very young infants. With dilatation of the urethra, no difficulty is experienced, as a rule, in passing sounds, catheters, and even "adult" cystoscopes in very young female infants, and ureteral catheterization may be carried out without difficulty.

In boys under four years of age, it is more difficult to carry out cystoscopy. Meatotomy with dilatation of the urethra will usually be necessary, even to introduce small children's cystoscopes, and ureter catheterization is practically impossible. In children over four years of age, cystoscopy and ureter catheterization under general anesthesia can usually be carried out with a small catheterizing cystoscope between 12 and 15 F. in caliber. Bilateral catheterization cannot usually be carried out in young boys, but unilateral catheterization, which may be repeated for the opposite kidney, is usually feasible and not especially difficult, even in small boys. Sounds, catheters, and small lithotrites can also be passed without much difficulty and the surgeons of India have reported great numbers of cases in which calculi have been crushed in small boys. We have reported elsewhere the use of a specially made small straight urethroscope with which a diagnosis of congenital valve of the posterior urethra was made, and a special small punch then introduced to divide a congenital valve in a boy of seven years. The result obtained was excellent.

Kretschmer and others have laid great stress on the importance of careful cystoscopic studies in urologic conditions in children. They have insisted that no great difficulty is usually experienced, when the proper instruments are at hand, in carrying out thorough diagnostic work, and that in pyelitis pelvic lavage is generally followed by very much better results than are obtained by internal medication.

[1] Journal of the American Medical Association, 1922, lxxix, 286–290. (An interesting discussion on the treatment of pyelitis accompanies this paper.)

[2] American Journal of Diseases of Children, 1918, xv, 116–131.

Detailed study of the genito-urinary organs in children is highly desirable. The condition of the genitalia should be carefully noted and congenital abnormalities sought for. These have been described in detail in other portions of these volumes. Congenital strictures and valves at the meatus and in other parts of the urinary tract often furnish immediate explanation for obscure urinary difficulties, and congenital defects, such as epispadias, are often associated with incontinence of urine. Among other congenital lesions which may be mentioned are hypospadias, exstrophy of the bladder, congenital curvature or chordee, undescended or partially descended testicles, and a bifid condition or other abnormality of the scrotum. Not infrequently cases of hypospadias are associated with other congenital conditions which make the diagnosis as to sex difficult, especially when pseudovaginæ are present. In such cases the rudimentary curved penis is held down by restricting bands and so covered by the divided halves of the scrotum that failure to recognize the masculinity of the patient is not uncommon.

Rectal examinations, with careful study of the prostate, the seminal vesicles, base of bladder, membranous urethra, and perirectal regions will often give valuable information. Instrumentation of the urethra with small bougies, sounds, catheters, and urethroscopes may be carried out in accordance with the technic laid down for adults. In the passage of instruments care should be taken to detect folds, valves, pouches, etc., particularly of the posterior urethra, which may explain congenital retention of urine or incontinence. If the passage of a catheter shows a large amount of residual urine, the same care should be taken as in adults not to immediately empty the bladder, lest complete suppression of urine and anuria follow, such as are seen with greatly distended bladders in cases of prostatic hypertrophy. Gradual decompression and antiseptic treatment of the bladder are of equal importance in such cases in children. Preliminary palpation of the suprapubic region is generally indicated, especially when vesical distention is present. The bladder capacity of a child of one year is about 100 c.c. To pass through the minute opening between congenital valves of the posterior urethra, a very small instrument, sometimes a minute ureter catheter, will generally have to be employed. We have had cases in which the only drainage possible for an overdistended bladder was obtained through a No. 6 ureter catheter, but this was effective in gradually decompressing the bladder and relieving severe uremia until the patient's condition was sufficiently good for operation to cure the congenital valve.

With a catheter in the bladder, cystograms can generally be carried out without difficulty and, if taken stereoscopically, often give a very accurate demonstration of the position and character of vesical diverticula. Spontaneous reflux of the vesical fluid into the ureters is not infrequently shown by the cystogram, and occasionally marked dilatation of the ureters and kidney pelves is demonstrated by this simple method.

Cystoscopy is surprisingly satisfactory with the very minute children's cystoscopes (12 F.). Splendid studies of the vesical neck, the bladder, and the ureteral orifices can usually be obtained. Ureteral meatoscopy alone will often give evidence of value as to the condition of the two kidneys; especially is this true in unilateral hematuria and pyuria. The presence of trabeculation, cellules, diverticula, hypertrophied trigone, and enlarged ureteral ridges are of importance in diagnosing obstruction to vesical outflow, and generally mean either congenital valves or strictures, even though such are not detected in the passage of the cysto-

scope (often having been previously ruptured by instrumentation). Ureteral catheterization is usually carried out in girls, even in infancy, with the usual double catheterizing cystoscope, and as infections of the kidneys are much more common in girls than in boys, a large class of cases is thus amenable to the diagnostic methods of modern urology. Unfortunately, these methods are rarely called into use and much propaganda is desirable to prove to clinicians the availability and simplicity of these important diagnostic methods, even in extremely small girls. After catheterization of the ureters the usual laboratory studies of the urine, the renal function, etc., may be carried out as in the adult. Pyelography, with the patient in both the horizontal and vertical positions, to determine abnormalities in shape, position and movement of the kidney, may be carried out with facility. With the demonstration of infection in one or both kidneys, pelvic lavage may often be carried out most satisfactorily and sterilization often obtained much more rapidly than by the methods of internal medication usually employed.

Infections of the Kidney.—As seen in the foregoing statistics, infections of the kidney furnish a large percentage of the reasons for admission to our children's hospitals and are more common in female infants and children than in males. The etiology is much the same as in adults. The far greater frequency in females is taken by some as an indication of the ascending character of the infection, as urethritis and cystitis are also far more common in girls. Many cases (particularly the coccus infections), however, are undoubtedly hematogenous in origin. Hinman found the kidneys free from infection in 50 per cent. of the cases in a series of 12 young girls with cystitis and pyuria. Here, as in adults, it is important to search for foci in other parts of the body. The infecting organism is usually a bacillus of the colon type, although staphylococci and other organisms of varied types are found, as in adults. (See section on Urologic Bacteriology.) The inflammatory lesion in children varies as in adults. We may find only slight pyelitis, but in most cases a pyelonephritis is present, and not infrequently a suppurative condition is associated with focal infections in the kidney and even outside of the kidney. An acute febrile reaction with severe systemic and general disturbance is commonly seen, and septicemia is far more frequent than in the adult. The severity of these infectious conditions of the kidney in children is shown by the fact that in both boys and girls the mortality rate in large children's hospitals varies from 10 to 15 per cent., and in boys frequently reaches 20 per cent. or more. In 20 autopsies in the Johns Hopkins Hospital, in addition to acute pyelonephritis and more extensive suppurative conditions in the kidney, lobar and bronchopneumonia were frequently seen. Otitis media occurred occasionally, but by far the most common complications were gastro-intestinal, and in most instances the immediate cause of death was persistent nausea, vomiting, and inability to take nourishment, symptoms undoubtedly due to chronic uremia. Associated terminal infections, such as pneumonia and septicemia, were not infrequently present.

The diagnosis of renal infections in children is usually not difficult. After finding a cloudy, purulent infected urine, generally associated with fever, and not infrequently with localized pain, tenderness and muscle spasm in the region of one or both kidneys, and sometimes definite enlargement, the diagnosis is clear. Cultures from the urine and blood should be taken and *x*-ray films made to determine the position and size of the kidney and the character of the lesion. Occasionally calculi are thus demonstrated. Careful renal function tests (phthalein,

blood urea, creatinin, etc.) should be done. When the renal function is good, and the general condition of the patient not serious, simple methods of internal therapeusis, as described elsewhere, may be carried out. In the presence of grave sepsis, ureter catheterization and pelvic lavage may be highly advisable, even at an early age. Kretschmer, Hinman, Stevens, Hyman, and others have insisted on the practicability of these important urologic methods in the very young and have demonstrated superior results by lavage.

With the recent development of intravenous germicidal therapy, the use of mercurochrome intravenously should be seriously considered. Some very brilliant results have been reported and, in our opinion, intravenous therapy offers a particularly attractive field in children. A particularly splendid case, reported to us personally by Wilkins, may be cited as an example.[1] In Gram-positive coccus infections of the kidney, although mercurochrome is usually more effective, gentian-violet and novarsenobenzol may be used. They are especially applicable in cases where mercurochrome has failed or they may be used intermittently with mercurochrome to avoid continuation of reactions. In the presence of septicemia, intravenous therapy is highly advisable and should be used without delay, generally in conjunction with forced water and possibly even blood transfusions. When the infection is unilateral and characterized by hydronephrosis or perinephric abscess, early operative drainage and sometimes nephrectomy are indicated. The technic of these procedures is described elsewhere.

Infections of the Bladder.—Cystitis may be either descending, ascending, or local in its character. In the descending cases, the infection is usually secondary to pyelonephritis, in the ascending cases to urethritis or urethral obstructions. In the local cases, chronic retention of urine, diverticulum, calculus, etc., are important etiologic factors. The complications and symptomatology are similar to those of adults and the diagnosis is usually made in the presence of cloudy infected urine. Cystoscopy is necessary to rule out renal infection. The treatment depends on the condition present and the complications, with the removal of which the disease will usually clear up under simple internal or local antiseptic therapy.

Infections of the Urethra.—Non-specific urethritis usually occurs as a result of uncleanliness and accumulation of secretions. It is more common in girls, but is not infrequently seen in boys, especially when a long phimotic foreskin is present. Such cases are usually associated with a marked balantitis in which the infection travels upward and may involve the entire urethra, and also the bladder. In girls non-specific urethritis is fairly common and epidemics are not infrequently seen in institutions. The commonest organisms are various cocci and diphtheroid bacilli. Not infrequently the cocci are diploid in arrangement and careful studies have to be made to differentiate them from the gonococcus (see Chapter III). Treatment consists usually in removing the cause of the irritation and maintaining cleanliness and external antisepsis. Water in large amounts should be given by mouth. Urethral injections are usually contraindicated. In severe cases intravenous therapy may be indicated, especially if evidence of general sepsis or metastatic foci are found.

Gonorrheal urethritis is also frequent in the male and female. It occurs in all ages of infancy and childhood. It is caused by contact with infectious sources,

[1] Young: Journal of Urology, 1925, xiii, 633–672 (Case 11).

such as the hands and genitals of nurses, playmates, and relatives, and with infected clothing and toilets. Cases are on record where such infections, innocently acquired from infected older members of the family, have passed through large families of children. The progress of the disease, the complications, and the symptoms are very similar to those of adults, but generally of less severity. Gonorrheal septicemia and endocarditis are extremely rare in young children. Conjunctivitis is another uncommon complication. Epididymitis and arthritis are occasionally seen. The treatment consists of rest in bed until the acute manifestations have subsided, liquid diet and imbibition of large amounts of water. Urethral injections and irrigations are usually much less satisfactory than in adults, but may be required to effect a cure. The disease, however, usually clears up without leaving serious complications. Cases are reported, however, in which extensive strictures of the urethra, resulting from gonorrheal infections in early childhood, have manifested themselves in later years. It has been suggested that the Gram-negative diplococcus concerned in many of these infections in children is an attenuated gonococcus, or not a gonococcus at all. This point should be cleared up.

Tuberculosis of the urogenital tract is not so rare in children as has been usually supposed. The upper urinary tract is much more frequently involved than the seminal tract, which in adult males is more commonly involved than the urinary tract. O. Muller[1] found renal tuberculosis thirty-three times in a series of 100 necropsies on tuberculous children, Dickinson[2] forty-nine times in 300 cases; Rilliet and Barthez[3] found 15 per cent. of 312 tuberculous children had renal involvement. The Berne pathologic institute reports 13 cases in a series of 126—almost 10 per cent.

Our own statistics are as follows: In 9 cases of genito-urinary tuberculosis treated in the Brady Urological Institute, 5 had reached puberty (fourteen years), and of these the epididymis was involved in 2, the kidney in 3. The other ages were eleven, ten, ten, and five years respectively, and all were renal in character.

Tuberculosis of the prostate, seminal vesicles, and epididymes is much rarer in children than in adults, but cases of bilateral tuberculosis in these organs have been described by various authors.[4] In 127 cases of genito-urinary tuberculosis in boys under the age of fifteen years Guyon found the prostate involved in 56, the prostate and vesicles in 11, epididymes in 2, and all these genital organs 58 times. The symptomatology of renal tuberculosis in children may be very indefinite and careful studies are often necessary. The *x*-ray and ureter catheter are of the utmost importance. The treatment indicated is practically identical with that in adults. In the presence of severe tuberculosis elsewhere, climatic treatment may be carried out, but when the disease is well localized in one kidney, early nephrectomy is, we believe, thoroughly justified and undoubtedly indicated.

Urolithiasis is very common in children in some countries. While far less common in America, Holt states that small stones are frequently voided during the first two years of life, and in a study of 1000 autopsies he found calculi quite common in infants.

[1] Quoted by Wildbolz: Chirurgie der Nierentuberculose, Neue Deutsche Chirurgie, 1913, vi.
[2] Ibid.
[3] Ibid.
[4] Young, H. H.: Archives of Surgery, 1922, iv, 334–419.

Rafin[1] reports 322 cases of calculus in infants, 140 under one year of age, and 26 in children between one and five years of age. Bokay[2] has collected 1836 cases of calculi in infants and young children, 1319 vesical. Thompson,[3] at the Canton hospital, in a series of 586 cases of urinary lithiasis, found 38 per cent. in children under fifteen years of age. Thomas and Tanner[4] have collected 203 cases of calculus in children in this country, and state that urinary lithiasis is frequent in childhood and infancy, the average age being seven and eight-tenths years. The youngest patient in their series in which this diagnosis was made was ten months old. Twenty-one per cent. of the stones were in the kidneys and only 8 per cent. were arrested in the ureters. Sixty-nine per cent. were found in the bladder or urethra, although many of these were of renal origin. The symptomatology, in order of appearance, is pain and colic, hematuria, frequency, pyuria, dysuria, nausea, and vomiting. In Thomas and Tanner's series of 203 cases, the diagnosis was made from the following positive findings: *x*-Ray 55 per cent., urinalysis, 52 per cent., cystoscopy 33 per cent., clinical findings alone 11 per cent. Seventy-eight per cent. of the operations in their series were for the removal of calculi of the bladder or urethra. The mortality was very small, there being only two deaths, one being a case of bilateral renal calculi, and one with malformation of the urinary tract.

Gilbert Barling[5] gives statistics showing the mortality in English hospitals in cases of vesical calculus in young males under twenty years of age: Suprapubic lithotomy, 72 cases, 12 deaths, mortality 17.4 per cent.; lateral lithotomy, 59 cases, 3 deaths, mortality 5 per cent.; litholapaxy, 59 cases, 2 deaths, mortality 5 per cent. Keegan,[6] in a report of 239 litholapaxies performed on male children, the youngest of whom was two and a half and the oldest fifteen years of age, stated that the mortality was 2.9 per cent. The average weight of the stones removed was 98 grains.

Süder[7] states that in children under fourteen years of age lithotrites, 7 or 8, English scale and 16 to 20, French scale, may be employed successfully. In most cases it was necessary to introduce the lithotrite from four to six times, but in 1 case twenty introductions were necessary. He thinks the only contraindications to litholapaxy in children are large size or great hardness of the stone, or very small dimensions of the urethra.

Urinary calculi in children may remain symptomless for years and not infrequently the most prominent symptom is frequency or incontinence of urine and handling of the genitalia by the patient during micturition. With intestinal colic, the child cries intermittently, while in the presence of ureteral stone the baby or child may cry for many hours because the pain is usually continuous. Sudden cessation in the crying may indicate that the stone has passed into the bladder or has passed through the urethra into the napkin. With ureteral stone, diarrhea is absent. This finding is usually positive with intestinal colic. The treatment of calculi of the lower urinary tract depends much on the size, character, and loca-

[1] Annales des Maladies des Organes Génito-urinaires, 1911, xxix, 481.
[2] Zeitschrift für Kinderheilkunde, 1912.
[3] Surgery, Gynecology, and Obstetrics, 1921, xxxii, 46.
[4] Minnesota Medicine, 1922, v, 147–152. (Lit.).
[5] British Medical Journal, 1894, i, 958.
[6] Lancet, 1892, ii.
[7] Annales de Obstet. Ginecol. y Pediat., June, 1888.

tion of the stone, as well as complicating conditions. Where the stone is small, one may wait for it to pass. Vesical calculi may often be treated most satisfactorily in children by litholapaxy. It is only necessary to have a sufficiently small lithotrite to remove calculi of even considerable size. Surgeons in India have been particularly adept in the removal of calculi from children in their country and one reporter cites 10,000 cases. Where the stone is large, litholapaxy is a tedious procedure and not free from danger, and although statistics show a smaller mortality for this operation than for suprapubic extraction, the latter operation is certainly to be preferred where the calculus is large or extremely hard. Another advantage of the suprapubic operation is that an opportunity is given for examination of the vesical neck and the removal of obstructive bars, bands, or valves which are not infrequently present and etiologically important. Marked trabeculation, cellules, and diverticula are distinct contraindications to litholapaxy. Where litholapaxy is done at one or more sittings, it should be followed by careful cystoscopy to determine that all fragments have been removed and to study the vesical neck for obstructions, and the bladder for pouches, diverticula, etc., which may have escaped detection. Perineal lithotomy in children is obsolete.

Congenital Obstructions.—Hydronephrosis and hydro-ureter are not uncommon. Küster, in a series of 500 cases, found 51 in children under ten years of age. Chronic retention of urine is not uncommon in children, and is usually due to obstructions in the urethra, more commonly in the form of valves, folds, or diaphragms in the prostatic urethra in boys, or at the vesical neck in girls. Congenital strictures may occur in portions of the urethra more distant from the bladder, particularly at the meatus, where they are not infrequently associated with a tight phimotic prepuce. Congenitally enlarged verumontanum, congenital hypertrophy of the trigone, hour-glass contracture, and vesical septa also lead to obstruction and vesical diverticula which may be single or multiple, marked obstruction to the ureters, and even difficulty in urination. Neuromuscular or spastic conditions at the vesical neck have also been described. Not infrequently no lesion is discoverable on careful clinical examination and through extensive operative wounds. Various authors have described idiopathic dilatation of the ureters and kidney pelves without discovering obstructions in the ureter, bladder, or urethra.

As described elsewhere, the symptomatology and diagnosis of these cases are often obscure, but in some cases are immediately evident. The patients usually give a history of marked weakness, emaciation, and digestive disturbances from birth. Their tenure of life is generally short and they may die shortly after birth. In the presence of grave anemia, asthenia, and emaciation, congenital obstructions should be suspected. Palpation will often reveal greatly distended kidneys on one or both sides and not infrequently the hugely distended ureter can be seen through the emaciated abdominal wall, and large hydronephrotic sacs are easily palpable. Such cases are usually associated with marked distention of the bladder, which is readily made out by palpation and percussion. Studies of the blood in such cases usually show evidence of marked renal impairment. When catheterization is carried out, great care to avoid immediate emptying of the bladder is necessary. The most careful precautions in carrying out gradual decompression and simultaneous water therapy are urgent. Preparatory treatment is practically identical with that used in similar conditions in the adult, for example, in connection with prostatic hypertrophy. A prolonged preliminary

drainage and water cure may be necessary before operative intervention can be carried out, and in the meantime cystoscopy and *x*-ray studies with opaque media may be utilized to complete the diagnosis. The treatment varies according to the conditions found present. Simple obstructive conditions of the lower urethra may be readily cured by minor operations or simple urethral dilatation. Valves, diaphragms, and bars in the posterior urethra and at the vesical orifice may be removed by simple dilatation or by punch operations, as described elsewhere (Chapter IX). In some cases perineal or suprapubic attack may be indicated, as shown in the cases cited. Valves and diaphragms of the prostatic urethra in boys furnish an extremely important series of cases. The first positive clinical diagnosis of and the first operation for this condition were carried out in this clinic. The results, in the series of 12 cases which we have now had, have been highly successful. Previously the result had been fatal in all the cases found in the literature. The subject was recently discussed at great length by Hinman and Kutzman.[1]

Tumors of the kidney occur in infants and children in relatively great frequency as compared with adults and furnish the greatest examples of huge renal tumors. Not infrequently the entire abdomen is almost completely occupied by the huge renal neoplasm which has grown with startling rapidity. The pathology, diagnosis, and treatment of these conditions have been described elsewhere at considerable length (Chapter VIII). The treatment usually consists in early operation. In rare instances radium and *x*-ray are successful, and in some cases remarkably so. It may be justifiable to attempt radiotherapy in inoperable cases, but where a radical operation can be carried out successfully by nephrectomy, it should be done without delay. Unfortunately, most of these cases arrive too late to be cured and the immediate operative mortality is high. Owing to the huge size of these tumors, a transperitoneal intra-abdominal operation is usually indicated.

Many of the tumors in the kidney region are embryomatous in nature and arise not in, but near, the kidney. For this reason separation and complete removal are difficult, and operative shock is often prominent. Even if the tumor is not malignant, it will recur if not completely removed. The little patients usually stand these extensive operations badly, but since death is inevitable without treatment, intervention is often unavoidable.

Hyman states that in a collection of 136 cases of kidney tumor, 106 were found in the first five years and 57 in the first two years of life, and that among these cases, pain was a prominent symptom in sarcoma and generally severe, whereas in the mixed form of tumors it is only present late in the disease.

The records of the Johns Hopkins Hospital shows 16 cases of kidney tumors in children under fourteen years of age. Ten were operated upon and the mortality was 90 per cent. One case was reported "well" two years after the operation.

Congenital Abnormalities of the Bladder and Urethra.—These have been described at great length elsewhere (Chapter IX). The treatment of hypospadias and epispadias, with or without incontinence of urine and exstrophy of the bladder, is purely surgical and they require, generally, repeated plastic operations to effect a cure. When complicated by marked abnormalities of the external genitalia, incomplete descensus of the testicle or aberrant position of the ovaries in inguinal canals or labia, and pseudohermaphroditism with pseudovaginæ and abnormal openings

[1] Journal of Urology, 1925, xiv, 71–112.

of the urethra in the perineum, very carefully planned and repeated surgical procedures are usually necessary. Before embarking on such extensive projects one should make absolutely certain of the real sex of the individual.

Tumors of the testicle are comparatively rare in children. They may metastasize to the retroperitoneal glands quite early, as in adults, and, although the indications for radical removal of the glands along with the original testicular tumor may be present, the operator is usually deterred from carrying out so radical a procedure by the great danger of a very prolonged operation under anesthesia in infants and young children. In a baby of four months, with teratoma of the testis the size of a lemon, the radical operation was carried out at this clinic with a fatal result, in spite of careful hemostasis and every effort to avoid shock. The patient died within forty-eight hours. The cause of death was not apparent. An unusual tumor (embryonal endothelioma), probably benign, is described in Chapter IX.

Sexual Precocity in Children.—Neurath[1] reported 27 cases of premature puberty in the male, the respective ages at which puberty occurred being as follows:

TABLE 190

Ages.	Cases.
At the end of the first year	8
Within the second year	4
Within third year	2
Fourth	3
Fifth	1
Sixth	3
Seventh	2
Eighth	2
Tenth	1
Twelfth	1

In the majority of the more pronounced cases excessive growth of the body had begun during intra-uterine life, while the premature and rapid development of the genitalia generally took place sometime after birth. Cases are reported, however, of both boys and girls born with unusually developed genitalia. The minds of these children, however, correspond to their real ages. Strauch[2] says that sexual precocity of the male presents as its most striking feature a premature, disproportionate, and excessive development of the genitals to the size of those of a grown man, and also an early development of the secondary sexual characteristics (hair in various parts of the body, deep voice). This excessive growth, however, is only temporary and the final size is generally smaller than normal. In the female the date of expulsion of the first mature ovum can be determined, but in boys the first nocturnal pollutions generally remain unnoticed. White[3] describes the case of a boy at the age of two years who practised masturbation with resulting ejaculation of sperma.

A thirteen year-old-boy, yet without crines pubis, reported by d'Outrepont, impregnated a girl nine years old, who still was without the slightest sign of puberty. This latter case demonstrates the well-recognized possibility in the female of a very early ripening of impregnable ova long before the onset of menstruation.

[1] Ergebn. d. inn. Med. u. Kinderh., 1909, iv, 46.

[2] American Journal of Diseases of Children, 1918, xv, 132.

[3] Med. Chir. Trans., 1815, i.

Up to the compilation of the literature by Neurath,[1] there were 17 cases of post-mortem and four findings during operations in both sexes; 14 girls and 7 boys. Five of these patients presented neoplasms of the sexual organs, 10 had neoplasms of the adrenals, 3 tumors of the pineal gland, and 1 hydrocephalus. Sacchi[2] reported a case of malignant tumor of the testis. At the age of five the tumor was the size of an adult testis, and the patient had grown very rapidly; the voice was deep, hair abundant on the genitalia. At six years the development of the body was enormous, and at nine he was 4 feet, 8 inches tall, and had abundant beard. The testicle was then removed, and proved to be "alveolar carcinoma." Four months later the beard disappeared, the voice became infantile, the penis less large and the sexual impulse, emissions, and erections ceased. His character also reverted to the infantile stage. Strauch[3] thinks that these genital tumors cause an increase of function of the interstitial tissue of Leydig, thus hastening the development of the secondary sexual characteristics. The same is true with tumors of the adrenals which often cause excessive growth of body, but early menstruation and orgasm are not reported. Strauch thinks that in childhood the pineal gland normally exerts an inhibiting influence on development, and that later the influence gradually diminishes and disappears, due to the partial involution of the gland. Experimental extirpation in animals leads to premature and excessive development of testes and secondary sexual characteristics. Five cases of pineal tumors, all males, and very precocious, are reported. In a few observations premature sexual development has been ascribed to masturbation and cohabitation due to seduction, but these are more likely effect than cause. Often the primary stimuli are not known, but it is established that the endocrine glands in some manner are of the greatest importance for the normal growth of the body and for sexual maturity, especially the gonads, adrenals, pituitary, thyroid, and the so-called "puberty" glands, the thymus and the pineal. The manner of their interaction still defies analysis, and the biologic laws, phylogenetic, racial, climatic, etc., that regulate the onset of these processes, remain obscure.

[1] Ergebnisse der Innere Medizin und Kinderheilkunde, 1909, iv, 46.
[2] Rivue Sperimentalle di Freniat, 1895, xxi (cited by Strauch).
[3] American Journal of Diseases of Children, 1918, xv, 132–140.

CHAPTER XXIII

UROLOGY AND UROLOGISTS IN WAR

AS EXEMPLIFIED BY EXPERIENCES IN THE AMERICAN EXPEDITIONARY FORCES

Foreword.—At the very inception of the organization of the American Expeditionary Forces it became evident that urology was to play a very important part. The first medical consultant appointed in France was for "the Division of Urology" which was organized as a specialty several months before any other departments of medicine or surgery were provided for.

Very early in the work it was suggested to the chief surgeon of the American Expeditionary Forces that a manual of military urology would be of great value in disseminating information on the subjects comprised in the Division of Urology. We were commissioned to prepare a volume on this subject. A rapid, but thorough study of the war literature, official compilations, and military hospital records was made, and a volume of about 300 pages was prepared for the use of the Medical Corps of the American Expeditionary Forces.[1]

In this volume the organization of the Division of Urology was outlined, as shown in the following quotation from the preface:

> In one of the subjects herein treated, venereal disease, the Medical Corps of the United States Army has, for eighteen years, had a proud record of achievement in decreasing the ravages of these infections, by education and prophylaxis. In the A. E. F. in France new problems have arisen, and the importance of minimizing the loss of effectives from these diseases has led to the development of greatly simplified methods which make it possible generally to provide thorough

[1] On January 8, 1918 the manuscript was presented with the following letter:

From: Major Hugh H. Young, M. R. C., France, January 8, 1918.
To: The Chief Surgeon, A. E. F.,
Subject: Manuscript for Manual of Military Urology.

1. In accordance with your request I submit herewith manuscript for manual dealing with venereal diseases, dermatology, and urology intended for the use of military surgeons of the American Expeditionary Forces.

2. This volume has been prepared in collaboration with Major Edward L. Keyes, Captains M. L. Boyd, Everard L. Oliver, W. H. Mook, and David M. Davis, and Lieutenants J. E. Moore and William Jack.

Hugh H. Young,
Major, M. R. C.,
Director of Urology, A. E. F.

First Indorsement

A. E. F., C. S. O., France, January 8, 1918.

1. I transmit herewith the manuscript mentioned and earnestly recommend that its publication be authorized as an official document for distribution to the American Expeditionary Forces.

A. E. Bradley,
Brigadier General.

Approved:
John J. Pershing,
General.

and consecutive treatment without evacuation of the soldier from his training area, or zone of the advance, thus avoiding the necessity of great base hospitals for venereal diseases.

This volume gives in detail a survey of the situation in Europe, the problems presented, the plan adopted, the therapeutic indications, and the systematized methods to be employed.

Skin diseases in the armies are also largely preventable, and much stress has been laid in this manual on methods of sanitation, hygiene, and early treatment by which it is hoped to keep the incidence to a minimum, and avoid evacuation for treatment from the zone of operations.

In the surgery of the genito-urinary tract much that is new and important has been discovered in the literature, records, and experiences of army surgeons. A careful study and compilation of this data has been made, and is presented with the hope of standardizing the war surgery in this field.

The existence of a large number of General and Special Orders, Regulations, Acts of Congress, etc., has made it advisable to have an appendix in which these are collected, along with data from French and English sources and brief papers of general interest.

"On account of the large number of official documents, and newly adopted standardized methods which are contained herein, it is hoped that all medical officers will take the opportunity to acquaint themselves with its contents and will carefully review at least those chapters which vitally concern their work.

"Our special thanks are due to General Pershing for his great and intelligent interest in the prevention and cure of disease, and the remarkable series of General Orders and circulars bearing on the subject which he has issued to the A. E. F."

The Manual of Military Urology proved of great value in standardizing the work of medical officers and was especially helpful to the division urologists and the consultants in urology for the base hospital centers, zones of the army, and of the S. O. S.

Much important literature has appeared since 1917 and it seems desirable, in order to make our Practice of Urology complete, to deal thoroughly with the work of the urologist at war, and in order to do so we have prepared a careful compilation of the literature, the experiences of our Allies, and the records of the American Expeditionary Forces. This put together as briefly as possible will form the basis of this chapter.

VENEREAL DISEASE

The treatment, and especially the prevention, of venereal disease, constitute perhaps the most important part of the work of the urologist in modern warfare, with its tremendous masses of men, often occupying whole countries and mingling intimately with the population.

During the great conflict we were able, thanks to the active interest of General Pershing, and to far reaching and stringent general orders which he issued, to reduce the venereal rate of the entire American Expeditionary Force to 16 per 1000 per year. This was accomplished by a vast program which we introduced, which comprised[1]:

1. *Social Hygiene:* For the purpose of providing recreation and minimizing the number of sexual contacts.

2. *Prophylactic Treatment:* For the purpose of preventing the development of venereal disease after sexual contact.

3. *Physical Inspection of Troops:* For the purpose of detecting venereal disease with the object of instituting prompt and efficient treatment in order to reduce

[1] Manual of Military Urology (prepared for the A. E. F. by H. H. Young, Colonel and Director Division of Urology, A. E. F.), 1917 (Masson et Cie., Paris).

the number of days sick; and of restricting leave in order to combat the spread of infection.

4. *Repression of Prostitution.*

5. *The Reporting of Sources of Infection and Dispensary Treatment of Civil Population.*

6. *Enforcement of Laws Relating to Alcoholism.*

7. *Court Martial for Venereal Disease.*

8. *Treatment of Venereal Disease with the Organizations:* In order to reduce the loss of effective strength and to avoid making venereal disease an excuse for escaping duty.

Army Houses of Prostitution.—Very soon after our arrival in France, the question as to the desirability of having army houses of prostitution was advanced in a document which went up through official channels. As the belief was then (and still is in some quarters) wide-spread that regulated prostitution offered the best hope of combating venereal diseases, we think that this paper, and especially the second indorsement, which is one of the most noted literary productions of the army, should be published here:

From: First Lieut. H. L. C. MORC.
To: Commanding Officer, B. S. No. 1 (Through C. O. Base Hosp. No. 101).
Subject: Control of venereal disease in St. Nazaire.

1. Having received requests for recommendations for the control of venereal disease in St. Nazaire, I wish to submit the following:

(*a*) That a number of prostitutes be employed who will be carefully inspected (and that only those be selected who have been found to be free of infection at the end of three weeks of careful observation).

(*b*) That these women be under military control.

(*c*) That all the enlisted personnel desiring intercourse be compelled to use these women.

(*d*) That all the men, on visiting these prostitutes, be compelled to show a certificate from their senior medical officer, stating that they are free of venereal disease, the certificate to be dated the same date as presented.

(*e*) That every man be compelled to take a prophylaxis under the direction of a trained man at the house of prostitution immediately after intercourse.

(*f*) That all soldiers be prohibited from entering any other house of prostitution, and that they be not allowed to go with any woman who is of ill repute.

(*g*) That any man contracting venereal disease be tried by court martial, and if it is found to have been contracted in a place other than the military regulated houses, his punishment be commensurate with the crime.

H. L. C.

First Indorsement

C. O. Base Hosp. No. 101, Oct. 6–17. To the C. O., B. S. No. 1 (Through Base Surgeon).

1. Forwarded, concurring in the opinion of Lt. C. that the only certain method of controlling venereal disease in this district is by the employment of the measures recommended or by similar measures.

2. If the program outlined does not conflict with the French law to such an extent as to make it impossible, I recommend that measures be taken to institute such a program in this city.

W. H. C.
Major, Medical Corps.

Second Indorsement

Office of Surgeon, B. S. No. 1, Oct. 10–17. To the Base Commander, B. S. No. 1.

1. In theory, this plan may be accepted as ideal, but as a practical expedient, it seems to require further development.

2. As it is proposed by an expert and is ably supported by qualified observers, I recommend

that a committee, composed as follows, be appointed to return working plans, detailed specifications and a general estimate of cost of installation and maintenance, including personnel and material required to reduce this theory to practice:

(1) Urologist to Base Hospital No. 101.

(2) Commanding Officer, Base Hospital No. 101.

(3) The Chaplain, 7th Engineers.

(4) The Chaplain, 19th Engineers.

(5) Local Secretary, Y. M. C. A.

(6) Surgeon, 3d Bn. 5th Reg. U. S. M. C.

3. The report of the Board should cover the following points, and answer the following questions, which must be carefully considered before the plan can be considered practicable and useful:

A. Female Personnel

1. How and by whom are the prostitutes to be selected?

2. What will be their terms of engagement—by direct contract with a military department, benevolent army associations, or commercial contractor?

3. What will be the length of service?

4. What guarantee of submission to regulations and restrictions?

5. Will service be limited to military clients to the exclusion of outside practice?

6. How may restrictions to limit service be enforced?

7. How far will control of personal movements and surveillance of personal conduct extend?

8. Will military authorities distinguish the women of good repute from those of ill repute in the civil community and place the latter in restraint?

9. What, if any, personal liberties may be enjoyed by the prostitutes?

10. As acceptance to military service is conditional on physical competence, when disability arises in the military service will it be considered "in line of duty" or due to "her own misconduct"?

11. What will be the responsibility of the Government in the case of temporary or permanent disability or death in this military service?

B. Male Personnel

1. Why limit this service to enlisted men? May not officers enjoy the same protection or be required to submit to the same restrictions as are imposed upon enlisted personnel?

2. What will be the exact clinical method of determining freedom from venereal infection, as it must be remembered that exacerbations of venereal disease appear after accepted clinical methods of examination have pronounced a cure?

3. In case of accidental infections, after all conditions have been complied with, will the ensuing disability be "in line of duty" and will the Government bear the economic loss?

5. What method will be employed to confine the attention of officers and soldiers to women in the military service, and how will the inclination to personal selection on the part of officers and soldiers be restrained?

6. Will enlisted men be confined to camp or permitted a restricted liberty under guard?

7. How will it be ascertained that a venereally infected soldier, who denies civil venereal patronage, has actually acquired his disease within the military zone?

8. In what numerical ratio to the strength of the command should prostitutes be provided?

9. What will be the disposition of women with honest and faithful service records, who fail in their desire to please and to attract patronage?

C. Material

1. In what quarters will militarized prostitutes be sheltered—in camp, in barracks near camp, or in houses in town?

2. What tariff arrangements will be made—shall a flat rate be established or the charge for service be rendered according to grade?

3. In what form will tariff be paid—may post exchanges issue checks which can be charged on the pay rolls after the manner of post exchange purchases?

4. Who will adjust financial disputes arising from the charges of the female for non-payment and the denial of the male of satisfactory service?

D. Social

1. Will there be different classes of physical environment as well as personal attraction at different rates of compensation for different military grades?

2. Will there be any race distinction made among the applicants for service or will "Jim Crow" principles be applied and receive official recognition?

E. Administration

1. What personnel will be required for administration?

2. What will be the grade and sex of the personnel required for the internal and external economy of the operating plant and for the hospitalization and detention departments?

3. How many medical officers, nurses, chaplains, quartermasters and benevolent civilian helpers will be required for the first installation of the plant?

3. It is believed that the plan herewith proposed cannot be executed unless all of these, and many other details, can be provided for before a practical demonstration may be begun.

4. As the system includes not only the control of prostitution, and the regulation of fornication, it should be presented frankly and fearlessly, as a military necessity of such vital importance that none need scruple at the moral conjectures it may suggest, and if it can be put into such practicable operation that it will control venereal disease.

6. But after all, it should be remembered that with any system of military control over the sexual indulgence of the soldier, instruction in the nature and consequences of venereal disease and appeals to his sense of self-protection should be largely depended upon. It should always be impressed upon him that continence is not only possible but that it is entirely feasible, and wholly practicable—especially for old men and senior officers, who should devote much of their time gained from this practice of continence to the instruction of young men who find themselves more occupied.

C. S. F.
Lt. Col. Medical Corps.

Third Indorsement

Office of the Base Commander, B. S. No. 1, Nov. 5–17.
To the C. G. A. E. F.—Through C. G., L. of C.

1. The recommendations for the establishment of a military house of prostitution at this base are not approved; but *not for the reason set forth in the second indorsement.*[1]

L. A. B.
Col. Infantry, N. A.

As is well known, the above methods were never adopted, or even seriously considered.

The following *directions for the prevention of venereal disease* were issued:

Prophylactic Unit: It is required that every military organization be equipped with a "prophylactic unit" ready for use at any post or camp where the organization is stationed.

When in temporary camp prophylactic treatments are perforce given at the hospital tent. When in permanent quarters a special room should, if possible, be set apart for prophylaxis and for the treatment of venereal diseases.

Directions for Use: 1. Genital organs will be thoroughly washed with soap and warm water.

2. An injection will be made into the urethra of 4 c.c. of the standard solution of 2 per cent. protargol dissolved in cold water. This should be retained in the urethra for five minutes.

The contents of one measure, level full, to 100 c.c. of cold water makes a 2 per cent. solution. This solution can best be made by emptying the contents of one measure (2 grams of protargol, or equivalent) upon the surface of 100 c.c. of cold water and letting it stand for a short time; in this manner a solution is quickly effected.

3. The entire penis will be rubbed with calomel ointment, care being taken that the folds of the prepuce and about the frenum are thoroughly covered. If any pimples or abrasions exist about the scrotum or the pubic region, these should also receive an application of the ointment.

[1] Italics ours.

The efficiency of the prophylactic treatment depends upon two factors, viz.: (1) The thoroughness of treatment, and (2) the interval of time elapsed between exposure and prophylaxis.

Duties of Officers: At the present time prompt prophylaxis is the one outstanding protective measure against venereal infection. The medical officer is under no more solemn obligation than that of insuring its utmost efficiency by

1. Careful instruction and inspection of the sergeants in charge of the prophylactic station.
2. Repeated instruction of enlisted men as to the necessity for prompt prophylaxis.

Commanding officers must also assist in every way possible. G. O. 77, par. 2, 1917, A. E. F., emphasizes this as follows:

"All commanding officers are directed to give personal attention to matters pertaining to the prevention of venereal disease. They will at all times support the medical officers charged with the management of prophylactic stations and assist in every way possible the prevention and eradication of venereal affections. No laxity or half-hearted efforts in this regard will be tolerated. It is expected that positive results will be obtained, and that all supplementary means to aid in that attainment will be encouraged. The number of effectives in a command is an index of its efficiency, and this depends upon the efficiency of the commanding officer."

Particular aid can be rendered by commanding officers in

1. Rigorous enforcement of the penalties for venereal disease (see G. O. 6 and G. O. 34, par. 7, 1917, A. E. F.).
2. Intimate study of such measures (*e. g.*, prohibition of overnight leave; see G. O. 77, par. 6) as will bring the men back to camp in time for prompt prophylactic treatment.

The development of the regulations for the control of venereal diseases in the A. E. F. is shown in the successive general orders and memoranda to officers and men, viz: G. O. 6, 34, 77; and memoranda of November 18, 1917, "For the Commanding Officers of All Troops Arriving on Transports," "Confidential Circular to Soldiers of the United States Army," of the same date, and the card urging men to avoid venereal disease, which is distributed to every member of the A. E. F.

It will be noted that this series of orders, the first of which appeared very soon after the arrival of the A. E. F. in France, has dealt in an increasingly comprehensive way with the problems of venereal prophylaxis and treatment among troops. The memorandum and the circular of November 18, 1917, and the card to soldiers, which are distributed to arriving troops while still on transport, are noteworthy for the forceful way in which the responsibility for the instruction of their men and for the punishment for venereal diseases is placed upon commanding officers. G. O. 77 specifically orders that a report be made of the "strength of the organization, name of the commander, and number of cases of venereal disease. . . . These reports will be filed at these headquarters with the personal record of the organization commanders and will be used as a basis in determining the commander's efficiency and the suitability of his continuing in command."

The rules laid down for the control of soldiers in camp, the limitation of leave, when granted, to three or four hours, and the designation of places where alcoholic liquors are illegally sold, as well as houses of prostitution, "off-limits," have had far-reaching results.

The Prophylactic Tube.—It has been found impracticable to provide convenient prophylactic stations for all the scattered organizations, details, and casuals of the A. E. F. in France. On this account it has been found advisable to issue a prophylactic tube which these men will use if they expose themselves to venereal contagion, against urgent advice to the contrary.

The tube is made of gelatin with the nozzle pointed and split at the end. The split remains coapted and opens only when the tube is squeezed to express its contents. The formula for the antiseptic ointment is:

	Parts.
Adipis	50.0
Calomel	32.5
Lanolin	15.0
Acid carbolic	1.5
Camphor	1.0

It will be seen that this is actually Metschnikoff's antisyphilitic salve (on which all modern prophylactic measures have been based) to which are added car-

bolic acid and camphor, the latter being used to form a "camphor phenique," which holds the carbolic acid in solution.

The prophylactic tube is distributed, wrapped in a small piece of paper which serves two purposes, viz:

1. To wrap about the penis after the treatment, in order to keep the grease off the clothes.
2. To convey directions of use.

"I. Much venereal disease starts in slight cuts or tears. This is particularly true of syphilis. This antiseptic lubricant, to be used before and after intercourse, will often prevent this disease, which is one of the most dangerous.

"II. Before having connection use the cream as a lubricant.

1. Insert conical end of the gelatine tube into the end of the penis (the pipe) and inject a little cream from the slit in the conical end, by squeezing the base of gelatin tube.
2. Squeeze some out on the head of the penis, smearing it all around the end and in the groove back of the head. Pull the foreskin well back, if necessary, before doing this.
3. If you have a long tight foreskin which will not retract or go back when you try to pull it back with your fingers go to a medical officer some time in the future and be circumcised.

"III. After intercourse.

1. Pass your urine and wash the whole penis well with soap and water, being careful to draw the foreskin well back and cleaning back of head.
2. Dry the penis.
3. Squeeze out some more of the cream into the canal of the penis and apply the rest of the cream to the head, neck, and body of penis, completely emptying the gelatine capsule and then rubbing the ointment carefully into the pores of the skin.
4. Also go as soon as you can to a prophylactic station and take the regular antiseptic treatment prescribed by G. O. 6 for all soldiers. This is absolutely necessary.
5. Contracting venereal disease is considered proof of failing to take proper early prophylaxis and is punishable under G. O. 6 and 34.

Continence is advised. Soldiers are commanded to take every possible means to keep themselves well.

Note.—The cream is not irritating or even unpleasant.

WRAP THE PENIS IN THIS PAPER"

Control of Prostitutes.—The house of prostitution is often a form of rowdy music-hall which allures hundreds where the clandestine would catch one. And the women in the former are so busily occupied with their scores of clients that they pass the infection from one man to another, acting as "human culture-tubes" filled with a mixed but virulent infection.

From the standpoint of the army, placing the houses of prostitution out of bounds and the prevention of solicitation unquestionably reduce the exposures and the consequent veneral infections. Just as diphtheria, spinal meningitis, and other infectious diseases are attacked the world over by isolation, so the only rational procedure in the effort to prevent soldiers from becoming infected with venereal disease is to keep them out of houses where prostitutes ply their trade.

Every endeavor will be made to locate the habitations, rooms, or apartments and sections of town occupied by women engaged in prostitution. All such places will be considered "off-limits"; they will be described and conspicuously posted.

Detection and Treatment of Infected Women.—No effort should be spared to identify such women and to force them to submit to appropriate treatment under penalty of banishment from the military zone. Civilian hospitals and dispensaries have been founded for this purpose.

Enforcement of Laws Relating to Alcohol.—The French law forbids the sale to soldiers of whisky, brandy, and liqueurs. The military and civil police can co-operate to assure the effectiveness of this law either by closing shops of recalcitrant proprietors or by placing them out of bounds.

G. O. 77 considers and expands this point, paragraph 12:

"12. Soldiers are forbidden either to buy or accept as gifts from inhabitants whisky, brandy, champagne, liquors, or other alcoholic beverages other than light wines or beer. Commanding officers will see that all drinking places where alcoholic liquors named above are sold are designated 'off-limits' and the necessary means adopted to prevent soldiers visiting them."

Strict enforcement of the regulations against alcoholism will go far to reduce the incidence of venereal disease.

Court Martial.—The rules for court martial of men contracting venereal disease as laid down in G. O. 6 and 34 should be strictly enforced.

Treatment of Venereal Disease.—In outlining a method of treatment for venereal diseases in the A. E. F. three cardinal requirements were kept in mind:

1. To treat the soldier as far as possible in his own command lest venereal disease be made a convenient excuse to escape military duties.

2. To treat promptly and efficiently the acute infectious manifestations of the diseases, both for the sake of the patient himself and for that of his companions in arms.

3. To minimize the later and more dangerous results of venereal disease.

Last year one army had 112,000 venereal patients who filled 18,000 hospital beds constantly. Fifteen hospitals were given over solely to the treatment of these cases. The treatment carried out at these venereal hospitals is usually thorough, but much time is lost in getting the patient to the hospital for treatment, the expense of transportation is great, the patient remains in the hospital about six weeks, and several more weeks usually elapse before he is finally returned to his organization at the front. Authorities report that this plan is demoralizing, that many soldiers have been known voluntarily to acquire venereal disease in order to get away from their commands, and that a premium is thus placed on getting venereal infection. Most important of all, syphilis is only partially treated, the patients are returned to the ranks with the probability of recurrences in a large percentage of cases, and no adequate subsequent treatment is provided. One authority estimates that probably over 90 per cent. of the cases of syphilis thus treated will recur. Even if this estimate is too high the picture of the thousands of cases of locomotor ataxia, paresis, and other late forms of syphilis, sure to occur among these patients, is horrible to contemplate.

It is evidently our duty to organize the venereal service so as to provide adequate, thorough, consecutive, and prolonged treatment for syphilis. This calls for intravenous injections of salvarsan or its substitutes intermittently over a year or more, together with appropriate mercurial treatment. As patients should not be kept away from their regiments indefinitely it is manifest at once that provision must be made for thorough treatment of all syphilitics with their organizations. Fortunately, intravenous treatment has been greatly simplified of late, so that it seems ridiculous to send soldiers many miles for a few intravenous injections, and entirely feasible to carry out these methods with the regiments or other organizations in training camp and rest camp infirmaries when the troops are at the front. As gonorrhea is no more difficult to treat than syphilis, it has been decided to equip special regimental infirmaries for the treatment of all venereal cases in order to avoid the construction and organization of huge venereal hospitals filled with thousands of men. The plan above outlined has been adopted and set forth in G. O. 34, which every officer is required to know and to explain to the men of his command.

In accordance with these provisions adequate regimental infirmaries have been established and proper equipment ordered. A urologist has been appointed to each division to supervise this work under the Director of Urology, A. E. F. Arrangements have been perfected for sending medical officers from each organization to certain large French military hospitals for practical experience in the new methods employed.

This plan has now been in operation for several months in the A. E. F., with very successful results. It has been found possible to detect venereal infections early and to institute immediate radical treatment. In certain cases where the organizations of a division were broken up or scattered, working parties of venereal patients have been formed where those not in the acute stages could be put to work while still getting adequate treatment at the camp infirmary.

A co-ordinate service with the object of detecting, curing, or eliminating venereal disease among the civilian population of the regions occupied by the A. E. F. has been organized to attack the sources of infection of troops.

This "American Medical Service for the Civil Population" (as it has been called) consists

of a central civil hospital erected by the American Red Cross, which provides the organization and quarters from which "teams," consisting of a medical officer, a visiting nurse, a chauffeur and automobile, go to visit daily a chain of clinics situated in adjacent villages and towns, in which dispensaries, with stated visiting hours, have been established. By conducting a general medical service women with venereal diseases may come for consultation without hesitation. With the increase in territory occupied by the A. E. F. other centers are planned and the central hospital furnishes provision for patients needing operation and hospital care.

This service has already been instrumental in detecting many cases of infectious diseases and has not only thus rendered the A. E. F. great service, but has accomplished much for the people in the region which is largely without medical attention, owing to the fact that four-fifths of the physicians have responded to their country's call to military service.

We publish these excerpts from the official Manual of Military Urology, A. E. F., because it is important that urologists, upon whom the organization and conduct of this work has fallen in the past, should be prepared to meet this great responsibility should another war come.

The *results* obtained were set forth in a report which we made after the war.[1]

Among 100,000 instances of prophylaxis given in Base Area Section No. 2, Bordeaux, the percentage of failure was 1.7 per cent. An analysis of the conditions among the troops stationed in Paris showed that the failure when prophylaxis was taken in three hours or less was 0.5 per cent. (785 cases).

The plan of keeping and treating men with venereal diseases within their organizations was followed to the end of hostilities. As long as the troops were in training areas or in very quiet sectors, little difficulty was experienced in treating men at regimental infirmaries; but when an active sector was occupied, the medical officer was so busy with other duties that it became necessary to organize venereal labor camps at which all the cases could be concentrated within the division.

Owing to the small amount of venereal disease present, none of these divisional venereal camps exceeded 180 men, even though certain cases of chronic gonorrhea and latent syphilis were taken for treatment. From 60 to 80 per cent. of these men were on a full duty status, doing important work for the division, such as repair of roads, stone crushing, erection of barracks and horse lines, sanitary work, carpenter work, and general mechanical work. It was shown that complications were not more frequent here than with men who had been hospitalized, and the active exercise and outdoor life had a wonderful effect in maintaining health and morale. Of great importance was the opportunity afforded to bring back to these divisional camps cases of syphilis for successive courses of treatment as the months passed by. In periods of great activity, and when an offensive was planned, these men were often sent forward to do their bit with their comrades, being allowed to return afterward to complete their treatment. Many of them made the supreme sacrifice, but there was no evidence to show that they did not fight as well as the others.

In many of the divisions, particularly those at the front, the amount of venereal disease contracted monthly was astonishingly small. The Forty-second Division had only 6 new cases in one month and 8 in another month among 26,000 men. When, however, troops were allowed to go on leave, the venereal rate increased considerably. During the last stages of the great conflict, when the divisions were being rushed forward into battle almost continuously for several months, the maintenance of the venereal labor camps was quite difficult, and it was proposed to organize army venereal labor camps to which all cases incapable of being handled with divisions would be sent. These were to be situated not too remote from the front, at places where work companies were needed for employment in useful occupations and as much as possible on full duty status. The sudden ending of the war made it unnecessary to organize these army camps. In the depot or replacement divisions venereal camps handled the problem among replacement troops very effectively.

General Pershing's interest in the venereal problem was actively maintained throughout the

[1] Young: Preventive Medicine as Applied to Venereal and Skin Diseases, Journal of the American Medical Association, 1919, lxxiii, 1668–1675.

war, as evidenced by the frequent orders, memoranda, and bulletins that he issued from time to time. His letter to Lord Milner shows his deep interest in the subject. This letter was incorporated in Bulletin 54, which was drawn up at his request. Although engaged in one of the great battles of the war, General Pershing took the time to review the manuscript and give his personal approval to it.

Results.—The figures as officially announced to the entire American Expeditionary Forces by the Surgeon-General of the United States Army are shown in Fig. 992. After the early rise, the result of the bad conditions at St. Nazaire, there was a steady decline until November 1,

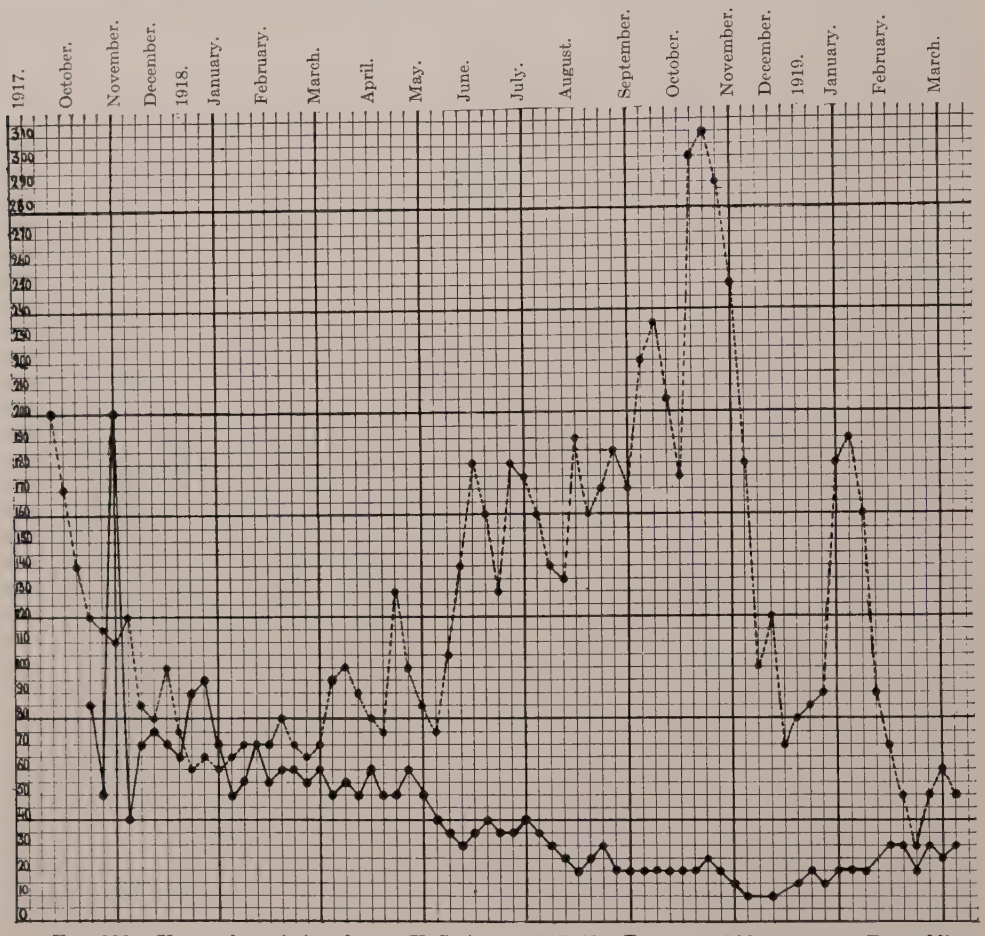


Fig. 992.—Venereal statistics chart. U. S. Army 1917–18. Rate per 1000 per year. Dotted line, troops in U. S. A.; solid line, A. E. F. The above chart shows that the army in France began with a venereal rate of 85 per thousand, and then in November the rate suddenly shot up to 200 per thousand per year. As a result of a vigorous campaign the rate rapidly dropped, and finally, during the last six months of the war, remained between 10 and 30 per thousand per year. This was in marked contrast to the army in the United States in which the venereal rate was greatly augmented by cases coming in from civil life, which in October reached the high mark of 310 per thousand per year, or 30 per cent.

1918, when the rate reached 16 per 1000 per year. Since the signing of the armistice there has been a slight increase, the rate during December and on January 1st being 28 per 1000 per year, less than one third of the rate in the regular army in 1916. In Fig. 992 is also seen the venereal rate of the United States Army stationed in the United States. As seen here in September, 1917, there was a rapid increase of the venereal rate due to the men coming in with the draft from civil life. From 1 to 8 per cent. of these men were infected with venereal disease (average: white men, 5 per cent; negroes, 15 per cent.), and the annual venereal rate of the army took a sudden great rise to 200. During the winter months of 1917 there were fewer drafts, and

the curve fell; but during the spring and summer of 1918, with the high increase of men from civil life, the venereal rate rose steadily until it presented the monthly rate of 228 per 1000 per year, and one week it reached the great height of 342 per 1000 per year. With the cessation of hostilities and the stopping of the draft, the rate rapidly dropped to 72, December 1st.

Statistics show that for every case of venereal disease acquired in the army in the United States, 5 were acquired from civil life and brought in with the draft.

A recent report shows that "in slightly over a year and a half, since the first drafted men were mobilized, there have been reported to the Surgeon-General over 225,000 cases of venereal disease among all troops in the United States. Approximately 200,000 of these cases were contracted in civilian life."

Experiences obtained in the American Expeditionary Forces, in which the venereal rate had been reduced to such a low figure, testify to the great value of the army methods for combating venereal disease, and the splendid effect of military discipline and the well ordered life of the soldier.

Following advices from other armies in Europe, preparations had been made by the Surgeon-General's office to provide one base hospital of 1000 beds for venereal diseases alone, for every 100,000 troops sent to France. Personnel and equipment of many of these hospitals were organized and 8 were dispatched to France, but venereal diseases had been so effectively combated, and the measures for their treatment with the organizations in the divisions and in the depot labor camps had been so effective and satisfactory, that it was decided not to use any of these hospitals for venereal disease, and they were promptly turned over to the treatment of the wounded and the sick.

In October, 1918, when the hospital resources in the American Expeditionary Forces were terribly taxed to take care of the wounded and sick, it was extremely gratifying to realize that of the 20 base hospitals which it was planned to provide for venereal disease for an army of 2,000,000 men, according to the original intentions of the War Department, not one was required for the treatment of venereal disease, and that every one of them was in use for other purposes and was available for the treatment of the wounded at that most trying time in the history of the American Expeditionary Forces.

In his very interesting and detailed account of Venereal Disease in the American Expeditionary Forces, Col. George Walker says:

"The observations in the American Expeditionary Forces have proved that prophylaxis is of the utmost value, and the fact has been established beyond doubt that when taken within one hour it is almost 100 per cent. effective. The number of men it will save from risk far exceeds the sum total of those individuals who expose themselves with the idea that they will be rendered immune because of prophylaxis. I do not believe that the introduction of prophylaxis is antagonistic to public morals, for along with the campaign for prophylaxis, the other campaigns of general education proceed *pari passu.*

"In addition to prophylactic stations . . . the health department should adopt a standard prophylactic package, consisting of 33⅓ per cent. calomel ointment with a base of 1 part vaselin and 9 parts lanolin; a tube of 10 per cent. solution of argyrol in equal parts of water and glycerin; a small piece of white soap; a tablet of 7½ grains of bichlorid of mercury, and about 1 yard of cotton bandage.

"These packages should be furnished at cost . . . and drug stores should not add more than 2 or 3 cents profit. By this means all would have access to prophylactic treatment; such a campaign is perfectly practicable. The public, as a whole, is in favor of it. We have it within our power to stay the spread of the most devastating curse of mankind."

SURGERY OF THE UROGENITAL TRACT IN WAR

Wounds of the Kidney

Incidence.—Wounds of the kidney occur in about 7 per cent. of penetrating abdominal wounds, and in about one-half the cases the kidney is the only organ injured, as shown in Table 191. In 232 cases classified by Rouvillois[1] the kidney wounds were as follows:

[1] Bulletins et Mémoires de la Société de Chirurgie de Paris, 1916, xlii, 708.

15 extraperitoneal visceral wounds, of which 8 involved the kidney.
48 wounds involving both thorax and abdomen, of which 4 involved the kidney.
169 intraperitoneal wounds, of which 6 involved the kidney.

The nature of the missile need not be especially considered, since the same injury may be caused by bullet or shell fragment.

Stab wounds are extremely rare and, apart from a tendency to bleed rather freely, require no special notice.

TABLE 191

INCIDENCE AND OPERATIVE MORTALITY OF RENAL WOUNDS OPERATED UPON AT THE FRONT (EXCLUSIVE OF THORACIC WOUNDS)

Operation.	Total number of abdominal wounds explored.	Total mortality, per cent.	Total kidney wounds.	Per cent.	Total kidney mortality.	Per cent.	Uncomplicated kidney wounds.	Mortality.	Per cent.
Col. Cuthbert Wallace[1].	965	53.9	73	7.5	22	30.1	34	6	17.6
Capt. A. L. Lockwood[2]..	356	52.0	33	9.3	15	45.5	13	4	30.8
Capt. J. Frazer[3].....	300	....	29	9.6	12	41.4	12		
Capt. C. F. Walters[4]....	500	51.0	20	4.0	8	40.0	10	4	40.0
Total.....	2121	52 (?)	155	7.3	57	36.8	69	14	24.6 (?)

Rupture of the Kidney.—Subcutaneous rupture may complicate a wound of the kidney or elsewhere in the body. Rupture of the kidney may be due either to the explosive effect of a bullet traversing the organ, to the concussion of the kidney by a wound of adjacent viscera (although the bullet does not actually touch the kidney), or to an injury other than a wound, such as the caving in of a trench, a fall from a horse, or burial by the explosion of a mine.

We have found the cases shown in Table 192, in which wounds of the kidney are cited, in the service records of the American Expeditionary Forces.

The literature contains a few interesting reports on renal wounds. In addition to those already mentioned, records of individual cases of interest have been published by Patel,[5] Barnsby,[6] Bazy,[7] Potherat,[7] Chevassu,[7] and Lapointe in the French journals, and by Fullerton[8] in English journals. The most comprehensive of these is that of Fullerton, who has published in detail his cases accompanied by a very voluminous analytic study, from which we will quote at length. O'Neill[9]

[1] British Journal of Surgery, 1917, iv, 679.
[2] British Medical Journal, March 10, 1917, 317.
[3] Ibid., 321.
[4] Lancet, 1917, excii, 207.
[5] Bulletins et Mémoires de la Société de Chirurgie de Paris, 1917, xliii, 839, 840 (presented by H. Hartmann).
[6] Bulletins et Mémoires de la Société de Chirurgie de Paris, 1917, xliii, 971–975 (presented by H. Hartmann).
[7] Bulletins et Mémoires de la Société de Chirurgie de Paris, 1918, xliv, 102–106.
[8] British Journal of Surgery, 1917–18, v, 248–288.
[9] Boston Medical and Surgical Journal, 1920, clxxxii, 213–319.

TABLE 192

INJURIES TO THE KIDNEY IN THE AMERICAN EXPEDITIONARY FORCES (66 CASES)[1]

Missile:	Number of cases.	Per cent.		Number of cases.	Per cent.
Machine gun	13	19.8	Second operation	10	15.2
Rifle	28	42.4	Third operation	1	1.5
Shrapnel	10	15.2	Right nephrectomy	7	10.6
High explosive	10	15.2	Left nephrectomy	5	7.6
F. c.c. bone	15	22.7	Laparotomy	11	16.2
Operated same day	28	42.4	Mortality in all kidney wounds	33	50.0
Operated next day	8	12.1	Received disability	22	32.3
Operated third day	1	1.5	Received no disability	10	15.2
Operated eighth day	1	1.5	Other organs injured:		
Inoperable	3	4.5	Large intestine	6	9.1
Débridement	33	50.0	Small intestine	3	4.5
Bone fragment removed	3	4.5	Liver	11	16.2
F. B. removed	24	36.4	Spleen	5	7.6
F. B. not removed	7	10.6	Chest	11	16.2
Drainage	42	63.6	Abdomen	26	39.4
No record	16	24.2	Spinal cord	3	4.5
Complicated	17	25.7			

has presented a few cases of kidney wounds operated upon by him at A. E. F. Base Section No. 2, France.

In a very detailed article Fullerton has reported in detail 42 cases of gunshot wounds of the kidney and ureter as seen at the Base:

Wounds of the kidney may be classified into (1) those involving the hilum and (2) those involving the parenchyma of the organ.

1. *Wounds involving the hilum* may be divided into:

(*a*) Those *involving the vessels*. If the main renal artery is divided, the patient may die of hemorrhage before he reaches the hospital. Where a branch is divided the patient may die. If not, that portion of the kidney supplied by this branch will undergo necrosis. It is important to remember that the arteries are terminal but that the veins anastomose. At operations carried out at a later date necrosis of a portion of the kidney supplied by the injured artery will be found.

(*b*) Those *involving the pelvis* of the kidney are rare and characterized by the discharge of urine through the wound, producing peritonitis if the abdominal cavity has been opened.

2. *Wounds involving the parenchyma* of the kidney vary from small perforations to complete destruction of the kidney. Escape of urine is not likely to take place unless the wound is large and has extended into the pelvis. If urine escapes from the external wound, the inference is that the pelvis or the ureter has been injured.

Cystoscopy was carried out in 14 cases to determine the effect of the wound on the kidney function, the condition of the opposite kidney, the extent of wounds in the ureter, and the position of a missile relative to a catheter in ureter and pelvis.

No definite statistics as to the value of ureter catheterization are furnished, but an examination of the recorded cases shows that nothing more than the pres-

[1] We wish to acknowledge our great indebtedness to Dr. W. LaRue Sherman and Dr. L. N. Fleming of Detroit, Mich., and to Dr. Leo E. Gibson of Syracuse, N. Y., for this study. The tables in this section are compiled from a personal examination of the records of individual cases in the files of the Medical Department of the United States Army. Those in Chapter X are from the collected statistics of the Medical Department. The numbers of cases here given are less than those in Chapter X, which include many cases the records of which were too scanty to be of value in a statistical study.

ence of an infection was determined in many cases. In a few cases, however, very important evidence was afforded.

By means of stereoscopic radiography he was able to estimate with great exactitude the position of the foreign body relative to the kidney or ureter.

Fullerton presents his method of utilizing a cross-section atlas of anatomy in an attempt to reconstruct the tract of the missile, a method which he describes as follows:

For my own purposes I use a cross-section atlas of anatomy. A key figure shows the body divided into sections of a certain thickness. Each of these slabs is numbered, and at the corresponding number in the atlas the organs and structures are figured as they are found at that

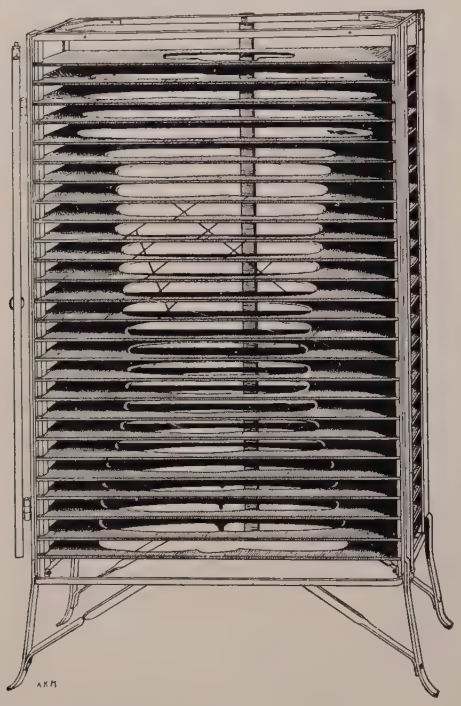


Fig. 993.—Diagram of frame used by Fullerton in reconstructing tract of missile in abdominal wounds in region of kidney or elsewhere. Each shelf corresponds to a plate in a cross-section atlas of anatomy, and the aperture fits the outline of the section at that level. Two tracks of missiles are shown. The point where the line of the track passes through the space in each shelf is determined by pasting a thread or wire across the space, and marking the spot where it is intersected by the line representing the track, as shown in Fig. 994, where the point of intersection lies in the kidney. Fullerton, British Journal of Surgery, v, 1917–18.

level. For use with this atlas I have had a frame with shelves made (Fig. 993). The frame supports the shelves, which are so arranged that each shelf corresponds to the upper surface of a section of the body at that level. Instead of each shelf having printed on its surface a drawing of the structure seen at this level, it has a large opening which just fits the drawing in the atlas. The circular opening, therefore, of this shelf corresponds to the contour of the body at that level. When the shelves are placed in position in the frame, and one looks from above down, a hollow space like a mold of the body is seen, and a thread may be arranged so as to stretch from the point of entrance to the point of exit or to the location of a foreign body, anywhere in the hollow space. The foreign body may be slung in the proper positon by threads or wires. The point at which the thread representing the tract passes through the circular aperture in each shelf can easily be shown by cross-threads, with an ink mark at the points where they are intersected by the thread representing the track. If this is done in each segment, and the shelves are placed

in turn so as to fit the plates in the Atlas, the organs or structures penetrated will be seen at a glance (Fig. 994). This has proved to be a very convenient method of reconstructing the track.

In cases seen at the Base, I found the most frequent associated injury a wound of the pleural cavity (40 per cent.). The missile had passed through or injured the liver in 33 per cent. of the cases, in 2 of which abscess developed around the foreign body. In most cases the tract through the liver gave rise to no urgent symptoms. Injury of the spleen was present in 1 case and of the spine in 6 (14 per cent.). The hollow viscera were injured in 5 cases as ascertained by operation; colon 3, small intestine 2, pancreas 1.

Very little is required in the way of treatment of urinary fistula at the base hospitals. Most cases will eventually close; if the fistula persists, a plastic operation or a nephrectomy may be required.

The causes of death, as seen at the base, are sepsis and secondary hemorrhage. There were 11 deaths in these 42 cases (23 per cent.). Five had injury of the spine, 1 of the pancreas, 1 of the chest, 1 of the peritoneum, 2 died of sepsis and secondary hemorrhage.

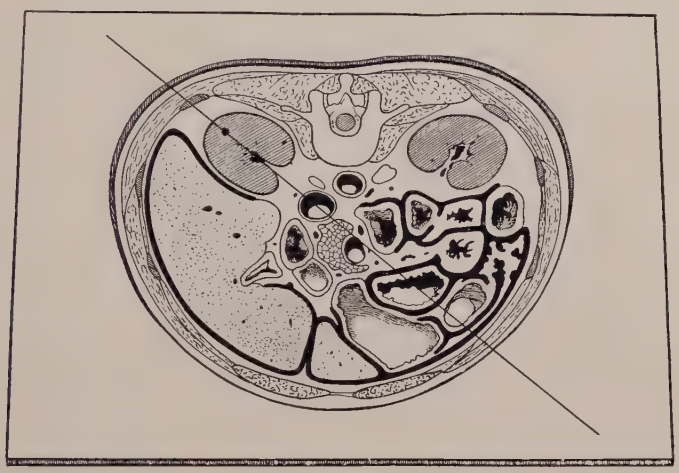


Fig. 994.—Diagram showing one of the shelves removed from the frame seen in Fig. 993, and fitted on a cross-section in the lumbar region. The dot in the right kidney represents where the missile passed at this level. The line on which is marked the point where the track passes through the space need not be oblique as represented in the drawing, but may be made in any direction so long as it touches the line of the track. Fullerton, British Journal of Surgery, 1917–18.

Pathology.—As shown in the foregoing statistics, the pathology varies greatly and depends on the character of the missile, its course, the structures and organs injured, infection, and other complications. If the parenchyma alone is injured, there may be little or no hematuria. If an important artery is divided, the parenchyma supplied by this vessel will become gangrenous, for the arteries of the kidney are terminal (Plate XX). Division of one of the main branches of the renal artery usually results in severe hemorrhage and death unless arrested by operation very early. Simple wounds of the renal pelvis lead to extravasation of urine. In uncomplicated wounds the mortality is only about 25 per cent. for those cases subjected to operation, and for those which do not require operation it is probably much less.

Clinical Picture.—The patient usually arrives at the evacuation hospital labeled as a wound of the abdomen, chest, buttock, or thigh. The surgeon's immediate concern is the state of shock, the amount of hemorrhage, the length of time since the patient was wounded, the character of the wound and whether symptoms point to perforation of the intraperitoneal viscera or pleura.

Symptoms.—Hematuria is always present unless the ureter has been completely

divided or the wound is parenchymatous and does not invade the pelvis. The bleeding may be slight or so extensive as to cause clotting in the bladder and retention of urine (which is common). Shock, in uncomplicated cases, is usually not severe and the hemorrhage in these cases rarely fatal. Hematoma frequently develops in the loin in wounds that do not drain freely, in which case the bleeding from the wound is often free, but if intraperitoneal, may not appear externally. Extravasation, secondary sepsis, and gas gangrene are the most common causes of death at the base. Secondary hemorrhage is quite common in the second and third weeks and has a tendency to recur. Renal infection and lithiasis are important late complications. The presence of a wound in the region of the kidney from which urine escapes renders diagnosis evident. All patients with abdominal injuries should be catheterized at the first opportunity unless they can urinate freely.[1] Urine obtained should be examined carefully for blood. If catheterization has been difficult and probably traumatic, the presence of microscopic blood may be of no importance. Hematuria is often the sole evidence of kidney injury where the wound is small. When there is only a primary hematuria which is slight, Barnsby states that one may wait and that spontaneous cure may occur. When the urine escapes into the abdomen, the injury of the kidney may not be recognized except at operation. In base hospitals cystoscopy and ureter catheterization can usually determine the source and character of urinary bleeding. In the absence of hematuria the cystoscope and ureter catheter may also give valuable information as to injury, renal function and infection. In a few instances wounds of the ureter have been disclosed in this way.

Treatment.—In the Manual of Military Urology we laid down the following directions:

1. Inspect urine for blood (catheterize if necessary).
2. Treat shock in the usual manner, by warmth and transfusion.
3. If in doubt whether or not to operate, the most prudent decision is usually the wisest.
4. If in doubt whether to open the belly or loin first, open the loin (see No. 6).
5. The loin incision should be transverse and extend approximately to the edge of the rectus. It may be enlarged by a vertical transrectus incision or by vertical incision along the outer border of the erector spinæ muscle long enough to permit division of all muscular and ligamentous attachments to the last rib. The twelfth dorsal nerve and artery may be avoided by placing the transverse incision a fingerbreadth below the rib. Thus also one avoids the danger of inadvertently entering the pleura, through mistaking the eleventh for the twelfth rib.
6. If there is a wound of the loin and hematuria, or if the wound plainly leads to the kidney, enlarge it transversely, deliver the kidney and examine the hilum for lesions of the renal vessels.

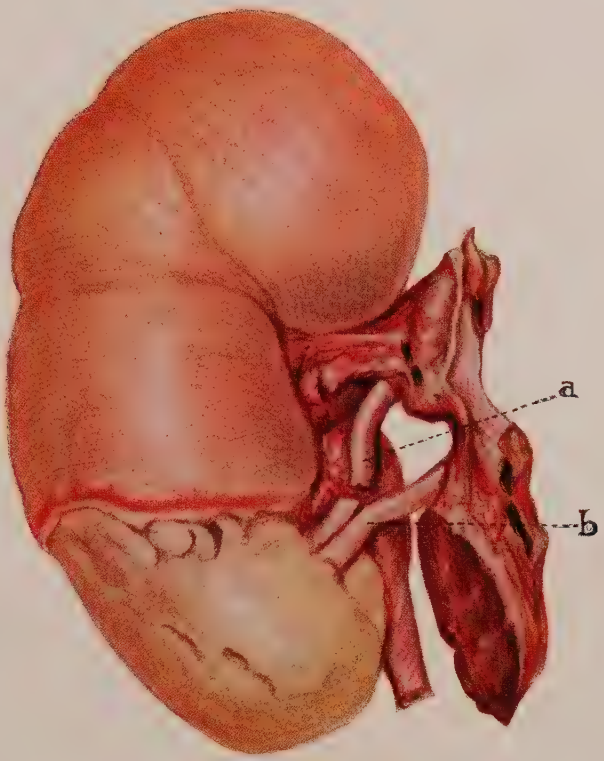
(*a*) If the main artery or vein or the upper main branch of the artery are wounded, perform nephrectomy.

(*b*) If smaller arteries or the lower branch of the renal artery are wounded or the renal wound is a relatively slight one, there are three alternatives. For wounds that are not very extensive or ragged and do not involve any great destruction of the arterial system of the kidney it may be wise to do nothing more than to pack the loin wound down to the kidney. But in case of persistent hemorrhage, extensive contusion, presence of foreign bodies, or division of arteries, the kidney demands the surgeon's attention; the renal wound may be packed or a portion of the parenchyma excised and sutured. At the evacuation hospital where such primary operations are usually performed, conditions are often such as to prohibit prolongation of the operation for the purpose of resecting and suturing the kidney or searching for shell fragments or bullets. Resection is, however, the ideal operation for such cases. When partial nephrectomy is performed the excised portion should include all that part of the kidney parenchyma which is deprived of circulation by division of its artery.

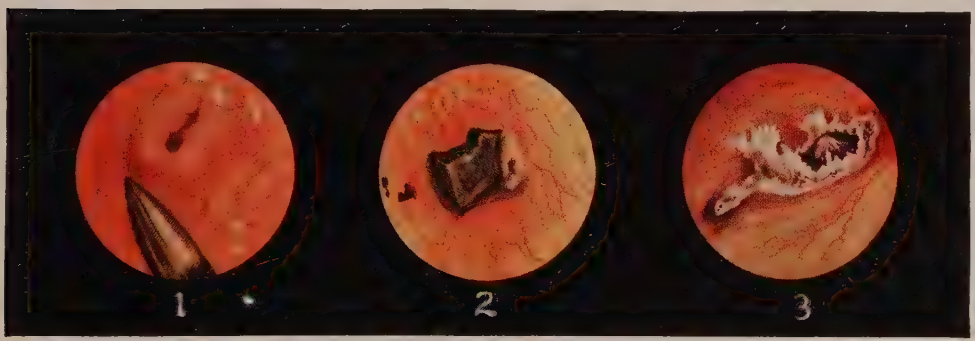
[1] Manual of Military Urology, p. 163.

PLATE XX

UROLOGIC WOUNDS OF WAR



A. Penetrating wound of left side; profuse hematuria; septicemia; death in fifteen days. Post-mortem: missile found to have traversed body of second lumbar vertebra, dividing a vessel passing to lower pole of kidney, finally coming to rest in liver. Autopsy specimen here shown shows necrosis of lower third of kidney supplied by the divided vessel. Case 31, Fullerton.* (Didusch after Maxwell.)



B. 1. Cystoscopic view of bullet in bladder adjacent to entrance wound. Moderate cystitis.

2. Cystoscopic view of small shell fragment in bladder, four days after injury. Slight cystitis.

3. Cystoscopic view of shell fragment and particles of clothing in ulcerating wound of bladder wall. Fullerton.* (Didusch after Maxwell.)

* British Journal of Surgery, 1917–18, pp. 248–288.

(*c*) A small tube should be left in the pelvis of the kidney two days, if this has been opened.

(*d*) Always open the peritoneum in front of the colon in order to examine the adjacent viscera.

(*e*) Drain and suture the wound in the usual manner.

7. If more than one-third of the kidney is contused, perform complete nephrectomy. If less, resection may be considered.

8. If hematuria suggests renal injury, but the wound is remote from the loin, the decision in favor of or against immediate operation should be based on the following data:

(*a*) If the patient is going to die of primary renal hemorrhage, he is likely to do so before reaching the dressing station.

(*b*) Though exploration of renal wounds usually starts a fresh parenchymatous hemorrhage, it discloses the fact that the primary bleeding has already stopped.

(*c*) Therefore, unless an external wound leads directly to the kidney region, the presence of hematuria or of retroperitoneal hematoma is no indication for immediate operation.

9. A retroperitoneal hemorrhage, discovered in the course of a laparotomy, may be disregarded (it often does not arise from the renal vessels at all) unless it is of enormous size, in which event it should be evacuated extraperitoneally, before the intestines are much handled, for it has been found that immediate grave shock results from turning the patient over and operating upon his loin after laparotomy.

10. Transperitoneal nephrectomy is generally condemned.

Barnsby remarks that surgery upon renal injuries should be as conservative as possible. Slight primary hematuria may cease spontaneously. If it is abundant and the condition grave, then intervention is necessary, but nephrectomy should only be done when the kidney cannot be saved. When the patient presents a series of recurring hematurias, there is most often a projectile in the parenchyma which can be removed after careful localization. When there is primary escape of the urine a wound of the pelvis may be indicated. If the patient's condition warrants, the wound may be exposed, the fragment removed, and drainage afforded.

The French surgeons insist that in kidney wounds hematuria should not force one to operation unless the bleeding is abundant and repeated.

Treatment at the Base.—All proposed operations upon the kidney should be preceded by cystoscopy and ureter catheterization, functional tests, and sometimes pyelography and fluoroscopy to determine the presence of fragments of missile or bone. Large hematomata should be evacuated to forestall infection. Secondary hemorrhage calls for transfusion and often nephrectomy. Sepsis should be combated by lavage, intravenous injections, or oral medication. Persistent urinary fistulæ may be treated by retained ureteral catheters or intermittent ureteral dilation and lavage with 1 per cent. nitrate of silver. Operation may be necessary to close the fistula, at which time the course of the ureter should be investigated and kinks removed, scar tissue excised and possibly closure or anastomosis carried out. Apparently at least 20 per cent. of the patients reaching the base with renal wounds die from sepsis or have grave kidney lesions. Renal and ureteral calculi not infrequently follow wounds and require operation at the base.

Results.—As shown in the records of the A. E. F. 50 per cent. of the patients with injuries to the kidney got well, 16 per cent. without operation. When we consider the complicated nature of most of these cases and the injury of important viscera, the results obtained are surprisingly good. In civil life, where it is possible to operate upon patients with greater promptness and with all the advantages of modern urology at hand, the results after simple and uncomplicated injuries of the kidney should be much better. Where patients can be retained indefinitely in

civil hospitals there is no need for the conservatism often required, especially in evacuation hospitals, in the Army. A study of the statistics given above should be of value in civil life in order to determine the probabilities of injuries of various viscera when given the course of the bullet. The experiences of war should, therefore, be of great value to practising urologists.

Wounds of the Ureter

According to statistics ureteral wounds are of great rarity. Many, however, may have been overlooked in dealing with serious multiple and complicated abdominal injuries. Only 2 cases are reported from the records of the A. E. F. In the first, the left ureter was severed by a machine-gun bullet. The patient was operated upon on the seventh day. A bone fragment was removed, débridement carried out, and no attempt made to anastomose the injured ureter, drainage being provided. The patient got well with atrophy of the left leg. He lost three hundred and thirty-four days and received disability of 33 per cent.

A second case is reported by Stevens[1] as follows:

> The patient was brought into one of the American base hospitals wounded in the back above the right costal region. This was classified as a chest injury, but examination showed neither chest nor abdominal signs or symptoms. Hematuria was the only pathologic finding other than the wound of entrance. Cystoscopy showed that the blood came from the right ureter, but a ureteral catheter was passed up to the pelvis and from it flowed perfectly clear urine free from blood. Hematuria continued for several days in decreasing amounts and finally disappeared.
>
> In the absence of any signs of urinary infiltration or ureteral obstruction, no abdominal exploration was performed. A machine-gun bullet was discovered by *x*-ray in the bony pelvis and its relationship to the ureter shown by shadowgraph catheter and fluoroscopic examinations. It was palpated by a finger in the rectum and removed through a lateral rectal incision. The patient made an excellent recovery.

The following interesting case, communicated to us personally by Captain Heitz-Boyer, is cited in the Manual of Military Urology[2]:

> Bullet wound of the left loin. On the third day wound incised, cleaned, and drained. Entered hospital on sixth day. Slight sepsis, urinary fistula in loin.
>
> The left ureter was catheterized to the kidney pelvis and injection of a few cubic centimeters of fluid elicited the pain characteristic of distention of the renal pelvis. No fluid issued from the fistula. Hence Capt. Heitz-Boyer concluded that he had passed by a lateral opening in the ureter. He therefore tied this ureter catheter in for eight days, washing the kidney pelvis once a day with boracic acid and 1 per cent. silver nitrate solution. Permanent cure resulted.

Treatment.—In many cases, owing to complicating conditions, wounds will not be recognized and, at most, treated by drainage. Immediate repair by suture would seem ideal if the lesion were slight and the diagnosis possible. The technic of ureteral repair and anastomosis are discussed elsewhere. Where reparative procedures cannot be immediately carried out, the ureter may be brought to the surface for drainage and fastened to the superficial wound until the patient is in condition for nephrectomy, which will usually have to be carried out unless some plastic operation to restore the continuity of the ureter is considered advisable (which is rare).

[1] Journal of the American Medical Association, 1919, lxxii, 1589–1593.
[2] Pages 171, 172.

Wounds of the Bladder

Wounds of the bladder were fairly frequent during the World War. In a series of 965 laparotomies performed at British Casualty Clearing Stations General Cuthbert Wallace found the bladder injured forty-five times, or 4 per cent. of the cases. Fullerton presented a detailed study of 53 cases of bladder wounds as seen at the base. He states that the very severely injured died at the out-posts, the ambulances, or casualty clearing stations and are, therefore, not included in his statistics, which included those who reached the base hospitals or were evacuated to England. Seventy per cent. were complicated by injury to the intestine or bone, or both. In 50 per cent. there was a wound of the lower intestinal tract and 25 per cent. were complicated by fractured bones. There were 19 cases of damage to the rectum, in 3 of which the wound was intraperitoneal and in 16 extraperitoneal. In 42 per cent. there was damage to the bones of the pelvic girdle, the sacrum being the most common. The prostate was injured in 7. The combinations of wounds were as follows:

TABLE 193

Wounds of the Bladder: Other Structures Injured

	Cases.
Bladder, pelvic bone, and rectum	11
Bladder, pelvic bone, and small intestine	2
Bladder and pelvic bone	9
Bladder and rectum	8
Bladder and small intestine	4
Bladder and pelvic colon	1

Legueu, in discussing 43 cases which he had observed at Necker Hospital in Paris, said that intestinal fistulæ were present in 15, but in only 2 was it possible to reach the site of the fistula by rectal examination. Among these 43 cases Legueu found fracture of the bones of the pelvis in 25, or 57.5 per cent. These lesions were as follows:

TABLE 194

Wounds of the Bladder: Associated Bone Injuries

	Cases
Lesions of the horizontal branch of the pubes	17
Lesions of the symphysis pubis	2
Lesions of the sacrum	2
Lesions of the iliac bone	2
Lesions of the hip-joint	2

These bony lesions are apt to be associated with severe infection, osteomyelitis, and abscess, and even after exterior healing may produce an osteopathic fistula of the bladder. In this fistula, which places the focus of osteomyelitis in communication with the cavity of the bladder and is associated with repeated formation of calculi, dead bone fragments are often present in the bladder. These conditions are not recognizable except by cystoscopy.

The cystoscope showed 22 cases in which there was a foreign body in the bladder, 8 missiles, 4 bone fragments, and 10 calculi (Plate XX). Chevassu reported that at his "automobile surgical ambulance" at the front he treated 17 cases of bladder injuries, with 10 deaths, among about 5000 severely wounded patients. These cases left the first-aid station with a primary diagnosis of wound of hips,

abdomen, or thighs. On arrival at the surgical ambulance, catheterization obtained a small quanity of bloody urine and the *x*-ray showed the location of the missile, if present. Jeanbrau reported 14 cases which presented grave pelvic lesions which he had seen at a surgical ambulance at the front. Two of these patients died. In those cases in which there was perforation of the bladder through which urine escaped and without peritoneal or intestinal injury, he simply inserted a retained catheter and evacuated the patient. In those with large hypogastric destructive wounds, involving the bladder, he placed a tube in the bladder through the wound. In all other cases he practised immediate cystostomy. Escat reported, among those seen at the front, 27 cases of bladder wounds in which the patient had recovered. Seven had received cystostomy, but in 20 no operation was done. The service records of the A. E. F. furnish the following statistics:

TABLE 195

INJURIES TO THE BLADDER. 57 CASES

Missile:	Number of cases.	Per cent.		Number of cases.	Per cent.
Machine gun	26	45.6	Cases complicated	27	47.3
Rifle	20	35.0	Second operation	17	29.8
Shrapnel	6	10.5	Third operation	3	5.1
High explosive	5	8.7	Received disability	17	29.8
F. C. C. bone	11	19.2	Received no disability	5	8.7
Secondary injury	17	29.8	Mortality	35	61.4
F. C. C. bone	3	5.1	Cause of death:		
Operation same day	27	47.3	Hemorrhage	2	
Operation next day	17	29.8	Shock	3	
Operation third day	3	5.1	Septicemia	3	
No record	8	14.0	Peritonitis	1	
Inoperable	1	1.7	Pneumonia	2	
Débridement	36	63.1	Not stated	24	
Bone fragment removed	5	8.7	Other organs injured:		
F. B. removed	17	29.8	Rectum	5	8.7
F. B. not removed	6	10.5	Large intestine	4	7.0
Drainage	45	78.7	Small intestine	15	26.3
Laparotomy	24	42.2	Abdomen	17	29.8
Cystotomy	14	24.5	Chest	3	5.1
No record	8	14.0			

Cause and Character of Wound.—As shown in the preceding statistics wounds of the bladder vary according to the missile, the direction, the injury of other structures, etc. Not infrequently the entrance wounds were high up in the chest or abdomen and very frequently the buttocks, thighs, hips, and genitalia were injured by the entrance or the exit of the missile. In the Manual of Military Urology the following dicta were given:

Experience of this war had gone far to eliminate the classic distinction of injuries to the bladder whereby they are divided into two groups, the intra- and extraperitoneal. In the description of symptoms and treatment, however, the distinction of extra- and intraperitoneal injuries must be maintained for the sake of clarity. But in the field the surgeon will find that most of the intraperitoneal bladder wounds are associated with extraperitoneal wounds and that the diagnosis of extraperitoneal injuries founded upon the absence of abdominal tenderness and rigidity may ultimately be belied by a fatal peritonitis. The following classification, therefore, simply represents the various combinations which may occur, and artificially dissociates the com-

plex pathologic conditions resulting from wounds of the pelvis or abdomen that involve the urinary bladder.

1. Intraperitoneal injuries.
   (*a*) Wounds.
      1. Uncomplicated.
      2. Complicated by
         (*a*) Perforations of other viscera.
            1. The small intestine.
            2. The colon.
         (*b*) Fractures or injuries of bones.
         (*c*) Injury to large blood-vessels.
   (*b*) Ruptures by concussion.
      1. Complicated.
      2. Uncomplicated.
2. Extraperitoneal injuries.
   (*a*) Wounds.
      1. Uncomplicated.
      2. Complicated by
         (*a*) Injury to rectum.
         (*b*) Injury to deep urethra or prostate.
         (*c*) Fractures of the bony pelvis or femur.
         (*d*) Injury to important blood-vessels.

Intraperitoneal wounds of the bladder are almost always associated with other intraperitoneal injuries, perforation of the small intestine being the most common, but injury of the large intestine and rectum occur with great frequency. In traumatic surgery no laparotomy should be considered complete until the bladder has been inspected on the operating table. Inflation of the bladder with air may be a great help. Symptoms vary according to the course and size of the lesion, the most prominent being a desire to urinate and inability to do so. Often the patient is able to expel a small amount of bloody urine. Hematuria is always present, but catheterization is generally necessary to discover it. Feces may also be found with the catheter or escape with the urine from wounds. Abdominal symptoms are similar to those of intestinal wounds. Fullerton[1] says that wounds in the buttock must be regarded with the utmost suspicion as an intraperitoneal wound of the bladder and other pelvic viscera may be entirely overlooked. He cites a case (No. 20) in which there was a wound of the left buttock; a catheter drew off 5 ounces of clear urine. A note from the clearing station stated that there was no vomiting, no rigidity, and no dulness in the flanks. Death took place at the base two days after the injury. Postmortem revealed four perforations in the small intestine and a wound of the bladder communicating at the bottom of the pouch of Douglas with the peritoneal cavity; general peritonitis was present.

When the rectum is injured the urine may escape into the rectum or gas or feces into the bladder or urethra.

Diagnosis.—This is made by the course and character of the wound, the abdominal and vesical symptoms, hematuria, and possibly escape of feces and signs of peritonitis, etc. The vesical wound is the most prominent. Attention may be directed to this and the intraperitoneal injury disclosed in this way. Where the abdominal symptoms are most prominent, laparotomy with exploration and rapid repair of

[1] British Journal of Surgrey, 1918, vi, 24–56.

injuries discovered should be carried out as speedily as possible. A hole in the posterior wall of the bladder may be closed with catgut after excising the torn edges of the bladder wall, being reinforced by approximation of the peritoneum. A retained catheter is usually employed for subsequent drainage. In such cases suprapubic drainage is not usually advisable, a retained catheter being preferable.

Prognosis.—The mortality of intraperitoneal wounds of the bladder has varied between 50 and 75 per cent. Intraperitoneal rupture of the bladder may occur by concussion without penetrating wounds, as shown in cases reported by Fraser and Drummond, Robertson, and Fullerton. The diagnosis in these cases may be extremely difficult, catheterization with recovery of bloody urine, measure of vesical capacity, and abdominal examination being necessary.

Extraperitoneal Wounds.—Wounds of the buttocks, thighs, hips, perineum, or genitalia, with little or no evidence of any abdominal disturbance or discomfort, frequently invade the bladder extraperitoneally and should always be carefully investigated. Fracture of the bones of the pelvis or thighs occurs in a large percentage of the cases.

Symptoms.—Uncomplicated extraperitoneal wounds of the bladder produce hematuria, difficult urination, and extravasation. There may be escape of urine and blood from the wound of exit or entrance and the extravasation may not appear at the surface but follow some of the planes of fascia. If lateral or in front, it may travel upward between the peritoneum and the abdominal muscles and offer little evidence for recognition. Where extravasation passes out beneath the muscles and skin, its presence is readily determined by inspection, palpation, and percussion. Retrovesical extravasations may travel upward behind the peritoneum and offer great difficulties of recognition. Fraser and Drummond have called attention to the fact that the urinary infiltration may follow three routes, viz.: (1) it may pass through the great sciatic notch to the buttock; (2) it may pass through the obturator foramen to the thigh, or (3) it may pass through the inguinal canal to the scrotum.

Diagnosis.—A provisional diagnosis can usually be made with a catheter. Cystoscopy would be, of course, of the greatest assistance. Urine draining from the wound of exit or entrance is diagnostic and hematuria discovered by catheter is suggestive. The possibility of intra-abdominal and intestinal lesions should be thoroughly investigated and the adjacent bones carefully examined for fractures.

Treatment.—Authorities differ as to the extent of surgical intervention which should be carried out in cases of bladder wounds in the advanced surgical hospitals of the front. Where no evidence of intraperitoneal injury is present and adequate drainage of the urine occurs through the wound, a "let-alone" policy seems to be preferable. If there is evidence of apparent danger of extravasation, the wound should be enlarged and adequate drainage provided. In some cases it may be desirable to open the bladder in the median line suprapubically and drain at this point, carrying out or not, at the same time, a repair of the bladder wound, according to the circumstances of the case and to the condition of the patient. The bony fragments and missiles that can be extracted with ease at such operations should undoubtedly be removed. Otherwise the patient, who is usually in considerable shock, should receive supportive treatment and as little active surgical interference as possible. With injury of the urethra and rectum, adequate drainage is often

at hand and the surgeon may content himself with débridement. As mentioned before, where the abdomen is penetrated and the intestines injured, immediate exploration and appropriate surgical intervention to repair the intestinal defects should be carried out. At base hospitals and at points distant from the front, sufficient opportunity is usually at hand for a careful history and a thorough examination, including cystoscopy. The foreign body can then be carefully localized and removed by means of conservative procedures at which time injuries to the bladder and urethra are repaired. Where the rectum is in open communication with the bladder, it may be reached either through an intraperitoneal or intravesical operation, and if low down, through a retroprostatic perineal operation, as described elsewhere.

Legueu insists that the proper operative treatment for rectovesical fistula is suprapubic drainage and he reports that 12 of his 15 cases were healed by this method.

Fullerton advises colostomy and drainage of the bladder through the wound of entrance. A great majority of the extraperitoneal abdominal wounds at the base of the bladder are inaccessible and must be left to heal spontaneously after proper urinary drainage has been supplied.

Summary.—Wounds of the bladder are usually complicated, extremely dangerous, and accompanied by a high mortality. If possible, they should be recognized and receive appropriate treatment at the hospitals of the front, special attention to the frequency of intraperitoneal and intestinal injuries being given. At the hospitals of the base and elsewhere, reparative procedures to remove foreign bodies and cure complicating conditions and to restore the urinary tract to normal are necessary and can usually be carried out with marked success. In civil practice the experiences of the bladder injuries of war can be studied with great profit.

Wounds of the Urethra

Wounds of the urethra can best be studied by dividing the subject into four parts: (*a*) Wounds of the posterior urethra and prostate; (*b*) wounds of the bulbous urethra; (*c*) wounds of the penile urethra, and (*d*) urethral fistulæ. The records of the American Expeditionary Forces are as follows:

TABLE 196

Injuries to the Deep Urethra. 10 Cases

Missile:	Number of cases.	Per cent.		Number of cases.	Per cent.
Machine gun	1	10.0	Bone fragment removed	0	0
Rifle	2	20.0	F. B. removed	2	20.0
Shrapnel	6	60.0	F. B. not removed	0	0
High explosive	0	0	Drainage	6	60.0
Grenade	0	0	No record	4	40.0
Bomb	1	10.0	Complicated	8	80.0
F. C. C. bone	2	20.0	Second operation	6	60.0
Secondary injury	4	40.0	Third operation	2	20.0
Operated same day	2	20.0	Fourth operation	1	10.0
Operated next day	6	60.0	Mortality (on the tenth day, cause		
Operated third day	0	0	septicemia)	1	10.0
No record	2	20.0	Received disability	6	60.0
Débridement	6	60.0	Received no disability	4	40.0

Wounds of the posterior urethra and prostate present problems very similar in many respects to wounds of the bladder. They are very frequently associated with fractures of bones, injury of the rectum, and, occasionally, intraperitoneal wounds with perforations of the intestines. There may be a partial division of the urethra or a complete division, generally with fracture of the pelvis. The usual injury is an extensive laceration of the urethra by a bullet or shell fragment. The missile in traversing the pelvis may also fracture the femur and produce lacerations of the rectum, bladder, and pelvic vessels. The usual symptoms are retention of urine, escape of blood and sometimes urine from the wound of entrance or exit or both, and urethrorrhagia, with escape of blood from the meatus. In some cases no urine escapes from the bladder, which becomes progressively overdistended. If urinary infiltration occurs, it may follow the routes previously indicated as governed by the anterior and posterior planes of fascia. This may be associated with severe shock and intraperitoneal symptoms. Slight injury to the prostatic urethra may produce only hemorrhage into the bladder, which may be overlooked, and may result in infiltration of urine.

Diagnosis.—With the presence of urinary retention, increasing vesical overdistention or perivesical extravasation, and a wound which may have reached the urethra, the diagnosis is made by the passage of a catheter. Wherever there is a fracture of the pelvis or bullet wounds in the pelvis, buttock, or thigh, a catheter should be passed into the bladder with most careful antiseptic precautions. If the urethra is ruptured, the catheter may pass well up into the pelvis, but it will not draw urine. Its position may be readily identified by palpating it with a finger introduced into the rectum; but a simple rectal examination will itself often reveal a rupture of the urethra or extravasated mass of blood or urine. Where the urethra is completely severed, the prostate may be pushed upward by the extravasation. If the catheter passes into the bladder, there may still be partial rupture of the urethra and in case the missile is a small one and has passed through the substance of the prostate, no treatment may be necessary other than an inlying catheter. In most cases, however, after the diagnosis has been made by the passage of a catheter, it is important to supply proper drainage by suprapubic cystostomy as well as perineal incisions to evacuate blood-clot, and even additional incisions (perineal and extra-abdominal) in case of extravasation and fracture of the pelvis. If a complete rupture of the urethra, with dislocation of the two ends, is found, immediate approximation with catgut sutures should usually be carried out if possible and if not, a catheter, inserted through a perineal urethrotomy wound and on into the bladder, may be sufficient to lead to satisfactory healing without stricture formation. Wide perineal drainage should be provided at the same time. If there is considerable loss of urethral tissue, extensive cicatricial contractures are apt to occur and will probably require subsequent plastic operations. In the primary operation it is desirable to do everything possible to prevent such contractions, but only after careful approximation of the two ends of the urethra has been carried out. If the urethral injury is complicated by a wound of the rectum, a primary colostomy should usually be done as early as possible. This alone may be sufficient to produce healing of the wound in the bowel, but it may be possible to freshen the cut edges and close the bowel through the perineal incisions used in exposure of the urethral wound. In many cases, however, recto-urethral fistula results and subsequent operation, as described elsewhere, will often be re-

quired to cure it. Interesting articles have been published by Pasteau,[1] Marion,[2] Luys,[3] and Colston[4] on the surgical problems of wounds of the urethra.

Pasteau lays stress on the importance of cleaning the wound as completely as possible, removing fragments of clothing, bone and shell, and the avoidance of resection of any more than necessary of the urethra, because one can never tell how much will live and be of importance later. During the healing one should attempt to place the extremities of the urethral canal which have been torn in line with each other by introducing a retention catheter and subsequently to treat strictures or other abnormal conditions which arise. Before attempting subsequent operations to close the urethra or to cure constricting conditions, one should wait until the wound has become soft and the infection minimal. He also describes a suspensory apparatus by means of which the patients with fracture of the pelvis are held immobile in the hospital train, and thus transported to the hospitals of the rear.

Complications.—In addition to the complications already mentioned, wounds of the deep urethra are not infrequently followed by fistulæ and strictures, both of which may urgently require treatment.

Marion has pointed out that in urethral examinations one must distinguish between a urethra entirely impermeable in the posterior part; a urethra impermeable in its anterior part, the posterior part connecting with the perineum by a fistula; and a urethra which, although slightly permeable, is the site of a stricture. Thorough examination includes the passage of filiforms, probes, sounds, colored solutions, combined rectal examinations, radiography in search for foreign bodies, projectiles, missiles, bone fragments, etc., and urethrograms and cystograms. The urethra may be found completely obliterated, the two ends separated by cicatrix, the urine passing entirely by a suprapubic fistula. Sometimes the two ends of the urethra do not correspond, with a stricture and fistula between. Sometimes the perforation in the urethra communicates either with the rectum or perineum by fistula. Peri-urethral abscesses, calculi, bone fragments, or missiles may be present. The prostate may be more or less completely destroyed.

Treatment.—This will depend on the conditions present. If it is possible to pass filiforms and progressively larger followers, such treatment may be sufficient to cure the stricture and lead to closure of the fistula. Failing in this, operation may be necessary through the perineum, in which appropriate methods (described elsewhere) may be utilized to relieve the stricture and cure the fistula. Where the urethral canal has been separated by extensive cicatrix, it may be possible, by freeing the respective ends, to draw them together around a retained catheter. Where the loss of substance has been great, a plastic operation, in which a vein or a piece of mucosa or skin is introduced to heal the defect, may be necessary. We would suggest that if simultaneous suprapubic operation is done, a portion of bladder wall may well be used for this purpose.

Recto-urethral Fistulæ.—Our experience in civil practice would indicate that the resection of the fistula-bearing cuff of rectal wall, which we have carried out so successfully, should be employed in these traumatic cases.

[1] Journal d'Urologie, 1919, vii, 407–414.
[2] Journal d'Urologie, 1917–19, vii, 384–406.
[3] Medical Record, 1919, xcv, 734.
[4] Journal of Urology, 1920, iv, 185–193.

Mortality and Results.—Colston has pointed out that the immediate mortality in cases of wounds of the urethra depends largely upon the complicating conditions, extravasation of urine and infection, both of which are serious as it is rare for the wounded man to receive surgical intervention within six hours from the infliction of his wound. The poor prognosis which most writers have noticed is dependent upon this unavoidable delay, and these correspondingly dangerous complications. The problems presented are graphically shown in the following case described by Colston:

P. H. G, private, Twenty-third Infantry, was wounded on June 14th at 2 P. M. by a shell fragment which entered the posterior aspect of the right thigh, passed just posterior to the femur, the exit wound being on the inner aspect of the thigh close to the perineum. The projectile then entered the perineum, severed the urethra close to the bulb, divided the left spermatic cord, and tore its way out through the abdominal wall in the left inguinal region, without entering the peritoneal cavity. The patient arrived at a mobile hospital at 10 P. M., where antitetanic serum was administered and immediate operation performed. The operation consisted of débridement of the thigh wound, left castration, and suprapubic cystostomy. Patient was evacuated June 22d, to Base Hospital No. 18, where he arrived on June 23d, by hospital train. Examination revealed a large sloughing wound of the hypogastric region, involving the recti muscles, suprapubic drainage wound, wound of thigh, incisions in left groin, scrotum, and dorsal surface of penis. Dakin's solution was applied continuously with frequent dressings. On June 28th the wounds were cleaner and the condition better, but suddenly the patient began to have clonic spasms and slight trismus with hyperactive reflexes. Diagnosis: Tetanus. Antitetanic serum, 20,000 units was administered. The general condition was worse the next day. A lumbar puncture withdrew fluid under tension. The patient received antitetanic serum, 10,000 units, subcutaneously each day. On July 3d a second lumbar puncture was done and 20,000 units given intraspinally. Steady improvement now began. On July 6th external urethrotomy, suprapubic tube removed. The good effect of dependent drainage afforded by the external urethrotomy was soon demonstrated in the condition of all the wounds. Several large sloughs separated from the suprapubic wound and the thigh wound filled in rapidly. Owing to the fact that this hospital was functioning as an Evacuation Hospital it was necessary to evacuate the patient on account of the exigencies of the service. Next seen June, 1919. General condition excellent, all wounds healed, perfect urinary control, urine passed entirely through a perineal fistula.

Wounds of the Bulbous Urethra.—These wounds, like those of the posterior urethra, are usually but a part of the grave injuries of the adjacent structures. The conditions present, the complications, the diagnosis, and the immediate treatment are very similar to those outlined for wounds of the deep urethra. Early suprapubic drainage for deviation of urine may be indicated unless contraindications are present, but perineal drainage is often satisfactory through the wound or through incisions easily made in the perineum. At the primary operation efforts should be made to preserve the urethra and, if possible, to restore its continuity by anastomosis, or simply by an inlying catheter with supporting sutures of catgut. Such procedures have rarely been carried out at the hospitals of the front and on this account marked irregularities of the urethral canal and extensive strictures are frequently encountered and require extensive plastic operations to effect a cure. The technic of these procedures naturally varies with the condition present, and are fully covered in the chapter on urethral surgery.

Wounds of the Penile Urethra.—These are usually associated with more or less extensive wounds of the external genitalia, penis, scrotum, testicles, cords, etc. The following table shows the incidence of wounds of the penile urethra or penis alone in the records of the A. E. F.:

TABLE 197

INJURIES TO THE PENILE URETHRA, OR PENIS ALONE. 43 CASES

	Number of cases.	Per cent.		Number of cases.	Per cent.
Missile:			Operation fourth day	1	2.3
Machine gun	12	27.9	No record	11	25.6
Rifle	15	39.5	Second operation	17	39.5
Shrapnel	12	27.9	Third operation	3	6.9
High explosive	2	4.6	Cases complicated	9	20.9
Grenade	1	2.3	Mortality (death occurred on fourth day from peritonitis)	1	2.3
Accidental	1	2.3			
Point of entrance:			Operation:		
Penis	29	67.4	Débridement	26	60.4
Thigh	9	20.9	F. B. removed	9	20.9
Buttock	1	2.3	F. B. not removed	1	2.3
Hip	1	2.3	Drainage	19	44.2
Abdomen	1	2.3	Dressing only	6	13.8
Secondary injuries	20	46.5	No record	11	25.6
Operation same day	18	41.8	Received disability	21	50.0
Operation next day	11	25.6	Received no disability	21	50.0
Operation third day	0	0			

The *complications*, *symptoms*, and *diagnosis* are evident. The primary indications are to control hemorrhage, to excise the contused tissue, to preserve the urethra as completely as possible, and to approximate the cut ends of the urethra with insertion of an inlying catheter if necessary. If the wound is small, no deviation of the urine may be necessary, the inlying catheter sufficing. In other cases either perineal or suprapubic drainage of the bladder may be advisable to allow the penile urethral wound to heal without the presence of urine. These cases are not infrequently associated with very extensive and destructive wounds of the corpora cavernosa which, in themselves, require most careful immediate attention, and not infrequently subsequent operations, to cure deformities and to restore the constituent structures of the penis to their proper continuity. DeSard has described a remarkable case in which the penis was almost completely severed along with the urethra, being held by the skin on one side. It had healed in this condition. After freshening the edges of the corpora cavernosa and of the urethra, reconstruction was carried out with complete restoration to normal continuity and function. Rochet and Cathelin have published very interesting cases in which ingenious operations were carried out to cure fistulæ of the pendulous urethra and in more extensive cases to restore the badly deformed penis to normal. In one of Rochet's cases the peripheral fragment of the penis was found embedded in a wound in Scarpa's triangle, being attached to the penis by a small strip of skin which was its only source of blood supply except that coming from encircling granulation tissue. At the end of five weeks the distal portion of the penis, which was almost completely swallowed up by granulations in the wound, was freed from its bed and restored to the proximal portion of the penis by sutures. The result obtained was excellent.

WOUNDS OF THE SCROTUM AND TESTICLES

These were far more frequent than wounds of any other portion of the genito-urinary tract, occurring in 164 cases in the service records of the A. E. F.

They were complicated by injuries of other structures, as shown in the accompanying table:

TABLE 198

INJURIES TO THE SCROTUM. 164 CASES

Missile:	Number of cases.	Per cent.		Number of cases.	Per cent.
Machine gun	33	20.1	Bone fragment removed	1	0.6
Rifle	62	37.0	F. B. removed	19	11.5
Shrapnel	34	20.7	F. B. not removed	2	1.2
High explosive	24	14.5	Drainage only	51	31.1
Grenade	5	3.0	Right orchidectomy	31	18.8
Pistol	2	1.2	Left orchidectomy	23	14.0
Accidental	1	0.6	Bilateral orchidectomy	2	1.2
Not stated	3	1.8	Second operation	45	21.3
Secondary injuries	78	47.5	Third operation	6	3.6
F. C. C. bone	10	6.1	Fourth operation	1	0.6
Operation same day	67	40.8	Cases complicated	49	29.9
Operation next day	47	28.6	Received disability	64	39.0
Operation third day	4	2.4	Received no disability	84	51.2
Operation fourth day	1	0.6	Mortality	15	9.0
Operation fifth day	1	0.6	Cause of death in 5 cases without		
Operation eighth day	1	0.6	testis wound:		
No record	36	22.5	Septicemia	1	0.6
Inoperable	0	0	Gas infection	1	0.6
Dressing only	32	19.5	Pneumonia	1	0.6
Débridement	48	23.1	Not stated	2	1.2

In wounds of the testicle Luys recommends the greatest conservatism, castration being performed only as a last resort.

In the Manual of Military Urology considerable space was devoted to the testicle and its internal secretion and the importance of its preservation, particularly if the other one was completely destroyed or required removal. The subject of testicular transplantation was discussed at length, in view of the fact that cases would undoubtedly be encountered in which both testicles were destroyed or required removal. We have no records to show that any attempt at testicular transplantation has been carried out in any of the armies. Bilateral orchidectomy appears to have been done only twice in the A. E. F. That beneficial effect may be obtained by testicular transplantation, either of the organ as a whole or sliced and embedded in the rectus muscle, has been shown by the reports of Lespinasse and others. An interesting case in which this procedure was carried out in our clinic was that of a man with undeveloped testes and grave systemic effects, in which two testes from a healthy male, who had just been hanged for murder, were implanted. One testis was placed whole in the scrotum and the other, cut in thin slices, was embedded in the rectus muscle. The patient was followed for six months and asserted that a most remarkable improvement in his general condition, sexual powers, and confidence in himself had resulted. The subject is one of great interest, but further experimental and clinical observations are desirable before definite statements can be made.

TABLE 199

CAUSE OF DEATH IN WOUNDS OF THE GENITO-URINARY TRACT IN THE A. E. F. 349 CASES

Type of case.	Hemorrhage.	Shock.	Septicemia.	Peritonitis.	Gas bacillus.	Pneumonia.	Not stated.	Total.
Kidney	4	3	1	1	..	..	24	33
Penis	..	..	..	..	..	..	1	1
Miscellaneous	..	..	..	1	..	..	..	1
Urethra	..	..	..	..	..	..	1	1
Bladder	2	3	3	1	..	2	26	37
Testicle	..	2	1	..	1	1	5	10
Scrotum	..	..	1	..	1	1	2	5
Totals	6	8	6	3	2	4	59	88

PARALYSIS OF THE BLADDER, WITH RETENTION OF URINE, FROM SPINAL INJURY

The genito-urinary complications which follow injuries of the spinal cord are of the utmost importance. Thompson Walker states that 90 per cent. of the cases of spinal cord injuries have serious infection of the urinary tract. Ultimately about 80 per cent. die of urinary infection. Injuries of the spinal cord produce vesical paralysis by breaking the continuity of the reflex arc controlling micturition, and immediate retention of urine results. The bladder becomes more and more distended and may reach such formidable size as to lead to fear of immediate rupture which, however, never occurs. In almost all cases dribbling of urine in small amounts finally occurs, and with the passage of time this increases so as to provide not only for the accumulation of urine but to lead to a gradual decrease in the amount of residual urine present. On this account Murphy, Besley, and others strongly recommended a course of non-intervention as to the bladder in such cases, and in the Manual of Military Urology the surgeons of the A. E. F. were urgently requested to follow this plan if possible. We have been unable to obtain accurate statistics as to how successful this was. In many instances we find that surgeons ultimately thought it necessary to provide suprapubic drainage or catheterization, intermittent or inlying, in order to relieve great vesical distension, but we know of many cases in which the non-intervention policy was carried out with satisfactory immediate results. It is impossible for us to find out what success this plan had in ultimately preventing the infection and ascending destruction of the kidneys in these cases. Horrax states that he often found it possible to empty a paralytic bladder almost completely by massage of the abdominal wall. Others have found that massage of the prostate increases the amount of overflow and thus reduces the amount of residual urine. Owing to the fearful mortality (at least 80 per cent.) which comes from urinary infection in cases of spinal injury, it seems evident that in both army and private practice every effort should be made to avoid both catheterization and suprapubic drainage. Where one of these becomes necessary most authorities seem to agree that suprapubic drainage is the safer of the two, but we know of instances where by very careful catheterization infection has been prevented for a considerable time. If the catheter is connected with our decompressing apparatus by means of which simultaneous drainage and antisepsis are obtained, the prevention of vesical infection is more easily accomplished.

CHAPTER XXIV

TESTICULAR AND PROSTATIC ORGANOTHERAPY

Testes.—It has been known from very early times that castration before puberty of both man and animals, besides causing the suppression of the sexual instinct, causes marked changes in bodily conformation and the so-called secondary characteristics of sex, such as changes in voice, absence of hair, etc. According to Berman, the author of The Glands Regulating Human Personality, the first to conceive the idea that the gonads exert their effect through an internal secretion poured into the blood was Bordeu, who was court physician to Louis XV. The first experimental proof of this, however, dates from Berthold, who in 1849 removed the testes from cockerels and transplanted them into new positions in the body.[1] He noted that the birds developed and retained all their male characteristics, such as voice, sex, and combative instincts, growth of comb, wattles, etc. When, however, the testes were extirpated without being replanted in the animal, these characteristics were lost. This work indicated that in the testes must be elaborated some substance essential to the growth and well-being of normal animals apart from other substances contained in the testes which had to do with the procreative function. Brown-Séquard in 1889 went further, and showed that injections of testicular extracts actually produced beneficial effects in castrated animals.[2] Extracts were made from dogs' and guinea-pigs' testes and were injected into animals and also into himself with what he claimed were beneficial results. The work of Brown-Séquard may be called the first experimental contribution to the so-called rejuvenating or tonic effects of testicular extracts. In recent years the idea of testicular rejuvenation has been revived in connection with grafting experiments. Such work has been done by Americans, namely by Lespinasse,[3] who reported a case of testicular transplantation in man and by Lydston,[4] who is reported to have done similar work with human grafts in one of the state prisons. More recently Stanley[5] and Kelker[6] performed the same operation and substituted the testes of animals for those of human beings. It was believed, however, that in all these cases the grafts became necrotic and were probably absorbed soon after the operation. Later investigations, however, have shown that such grafts are not so rapidly absorbed as supposed and may exert an influence on the subject for some time after the operation. Voronoff[7] has carried the work further in his experiments with so-called monkey glands. His earlier work was upon sheep and goats in which he grafted young testes into old animals and into castrated animals. He found the best results were obtained by implantation of the testes into the scrotal sacs. Retterer[8] and Voronoff, in a recent paper, state that the animals thus treated displayed improvement in their general condition and sexual vigor. The unfortunate feature of all the grafting and transplantation experiments is that other factors not depending directly on the grafts cannot be positively excluded. This is especially true of experiments on man. Thus, for instance, Lichtenstern[9] of Vienna operated on a soldier who, as a result of a wound in the war, lost his testes. After performing a grafting operation on

this subject, he found that the patient a few months later showed his usual vigor and was greatly improved. This result, however, could have very possibly been due to a change in his mental condition suggested by the operation.

Another form of testicular organotherapy has been described by Steinach and his school.[10] Experiments on rats performed by this investigator have shown that after ligating the vas deferens there is an atrophy of the sperm cells, but at the same time there takes place a proliferation of the so-called interstitial cells of Leydig, sometimes spoken of as the "puberty gland." In these animals it was noted that there was a general improvement in nutrition and the rats were more active and developed a new coat of hair. As a result of these experiments many operations of vasectomy and vasoligation have been performed by various surgeons on men and extravagant claims have been made as to the results obtained. The present status of the Steinach operation may be perhaps summarized by the experimental work carried out by Macht and Teagarden.[11] These authors performed vasoligation on very old rats and studied by special methods their behavior and general condition before and after operation. They found that certain changes did occur after ligating the vas deferens. The animals became more active, they grew more hair, and behaved generally like younger rats. These changes, however, persisted only for a few weeks, after which the animals generally relapsed into their usual senile state.

A great many testicular extracts and preparations have been exploited by unscrupulous dealers and charlatans. At the present state of our knowledge *there is no evidence whatever that administration of such products by mouth produces any physiologic changes* in either animals or man. This does not, however, imply that injections of such extracts, grafting and transplantation experiments or vasoligation are absolutely worthless. A conservative and wise attitude on the subject is perhaps that of F. H. A. Marshall, who in a recent paper states that, "it must be pointed out that the accumulation of evidence in support of the contention that a testicular graft obtained from another individual and even another species may exert a definite physiologic influence upon the recipient, is considerably greater than many men of science have so far been disposed to admit."[12]

Prostate Gland.—The idea of an internal secretion of the prostate, unlike that of the testes, is a very recent one. Heretofore it has been held that the only function of the prostate gland was in connection with the viability of the spermatozoa, as shown by Walker and others.[13] In the last few years considerable evidence of an experimental nature has been accumulated, pointing to a possible endocrine function of the prostate gland as well. The chief evidence in this connection is summarized by Macht in Barker's Endocrinology.[14] It was found that the feeding of the prostate substance of animals as well as of man to tadpoles hastened their metamorphosis not unlike the thyroid gland, but, unlike the thyroid, it did not retard their growth. Experiments on the effects of prostate on the mental efficiency of rats performed by Macht and Bloom[15] indicate that the prostate does not exert any effect on the central nervous system. On the other hand, experiments by Macht and Ulrich[16] on the effect of the prostate on the neuromuscular efficiency of animals revealed some very interesting facts. It was found by these authors that after prostatectomy animals exhibited distinct weakness of their muscles, as indicated by special methods of study, and these authors have further found that the feeding of dry prostate gland produced a slight improvement in

the muscular efficiency of the animals. These experiments are the only ones in connection with the prostate gland which have shown any effect at all to follow the feeding of dry gland substance. The question of endocrine function of the prostate gland, however, is not yet settled and further work along these lines is very desirable.

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CHAPTER XXV

STUDY AND TEACHING OF UROLOGY

Equipment.—Urology as a specialty has been a late development. For many years venereolgy alone was to be found in the out-patient departments and hospital clinics, often combined with syphilology and dermatology.

When one of us, in 1897, was transferred from his position of assistant resident surgeon to take charge of the out-patient genito-urinary department meager quarters were provided in two small rooms with no hospital service attached. Only four years before our predecessor, Dr. James Brown, had been the first to catheterize successfully the male ureters and a few months later Kelly had made his important contributions in cystoscopy and ureter catheterization in the female. The untimely death of Dr. James Brown caused the transfer of the assistant resident surgeon, who protested that he knew nothing about the specialty but was reassured by Dr. Halsted's reply, "I know you don't know anything about it, but I hope you can learn."

In a short space of time, however, great progress was made in Europe and eagerly taken up in America, amazing advances in urethroscopy, cystoscopy, ureter catheterization, and operative and photographic cystoscopy being brought rapidly to successful fruition. The *x*-ray, introduced into medicine about this time, immediately found in the field of urinary diseases a most successful application, and the rapid development of shadowgraph radiology and Casper's phloridzin functional test gave a great impetus to renal diagnosis and surgery, the capstone of which was added by the perfection of the phthalein test and the development of effective methods for repairing back pressure lesions of the kidney by proper preparatory treatment. *Pari passu* came in rapid order the brilliant development of the surgery of the entire urinary tract: suprapubic and perineal operations for prostatic hypertrophy; radical cures of carcinoma of the prostate and penis; the "punch" operation for contractures and bars; accurate cystoscopic methods for vesical calculi; cystoscopic rongeur and foreign body forceps for the accurate diagnosis of vesical tumors, quickly followed by the introduction of fulguration which transformed the treatment of benign papillomata; the development of safe intravesical methods for the enucleation of vesical diverticula and the restoration of the ureteral orifice into the bladder cavity without resection and transplantation; the demonstration of submucous cystitis as the cause of inexplicably painful bladders; the introduction of ureteral dilation to facilitate the passage of calculi and the treatment of strictures of the ureter; application of radium to the treatment of prostatic and vesical carcinomata; introduction of conservative operations upon the ureter, pelvis, and kidney in calculus and hydronephrosis; the radical resection of the diseased half of double and horseshoe kidneys; the more radical removal of tumors by transperitoneal nephrectomy with the glands, adrenals, and adherent peritoneum; finally, the radical cure of tuberculosis of the entire genito-urinary tract by more accurate and more extensive methods. These and other great improvements rapidly forced upon a somewhat unwilling profession the demands of

the urologists, as they began calling themselves, for a special department in general hospitals and university clinics.

For years the surgery of the eye and of the throat had been recognized as worthy of special departments and entire surgical charge of their cases, but even now the right of the surgical urologist to claim surgical work in his department as his own is combated in some quarters. However, just as it has been demonstrated in ophthalmology and laryngology that the special student of these diseases who makes the diagnosis is best prepared to operate and carry his case to successful conclusion, so surely will it eventually be found that the urologic surgeon, who is responsible for most of the great developments which have been made in urologic surgery, is best prepared to do this surgical work; and hospitals and universities must eventually come to complete and cordial acceptance of this fact.

Urology possesses unquestionably the most perfect diagnostic instruments and laboratory methods in the entire field of medicine and surgery. But what has brought about this splendid achievement in accurate diagnosis and skilful operative relief? First, the fact that high class surgical work requires high class mechanical and technical men, and, if possible, personal training and skill in such by the operators themselves. With the mechanical talent, ability as draughtsman to convey one's conceptions and ideas goes hand in hand, and a survey of the literature shows many remarkable instances in which mechanics or art, or both, were developed to a marked degree in the great men of medical science. We need mention only a few: Vesalius, the father of anatomy; Ambroise Paré, the father of surgery; Karcher, the inventor of the microscope; Cheselden, the great English surgeon, who designed Putney Bridge; Scarpa, Henle, His, Charles and John Bell, Leidy and Lister, all of whom illustrated their own works with beautiful drawings; Charcot, the great neurologist, and Seymour Hayden, one of the greatest painter etchers of all time, as well as a great surgeon.

Urology, probably more than any other specialty, owes much to mechanics and art in her devotees. The four moderns who did most to develop the science are Nitze ("der grosse Techniker"), Henry Thompson, Henry J. Bigelow, and Felix Guyon. All of these epoch-making men were great mechanics, inventive geniuses and idealists, whose spirits were never satisfied with the existing order, but constantly strove for perfection of detail, as well as broad advancement in the field.

The second factor in the modern advancement in urology has come about as a result of a closer co-operation between clinic and laboratory; for there is no branch of surgery which offers greater field and opportunity for varied laboratory work than urology.

A recognition of this fact led us, when preparing the plans for the James Buchanan Brady Urological Institute in Baltimore, to provide a varied assortment of laboratory and research facilities presided over by well-trained men. Not only were laboratories for pathology, bacteriology, and clinical microscopy provided but also for chemistry, physics, and animal experimentation, with a well-equipped machine shop to make new apparatus and surgical instruments.

In discussing equipment we can best approach the subject by a partial description of what we have attempted to do at the Brady Institute.

We first made a study of hospitals here and abroad, but could find only one—St. Peter's, in London—solely devoted to urology. We then proceeded to perfect the plans and specifications for a building in which the laboratory and experi-

mental side should play a very important rôle, and in which clinical material, public and private, out-patient and in-patient, could be used for study, research,

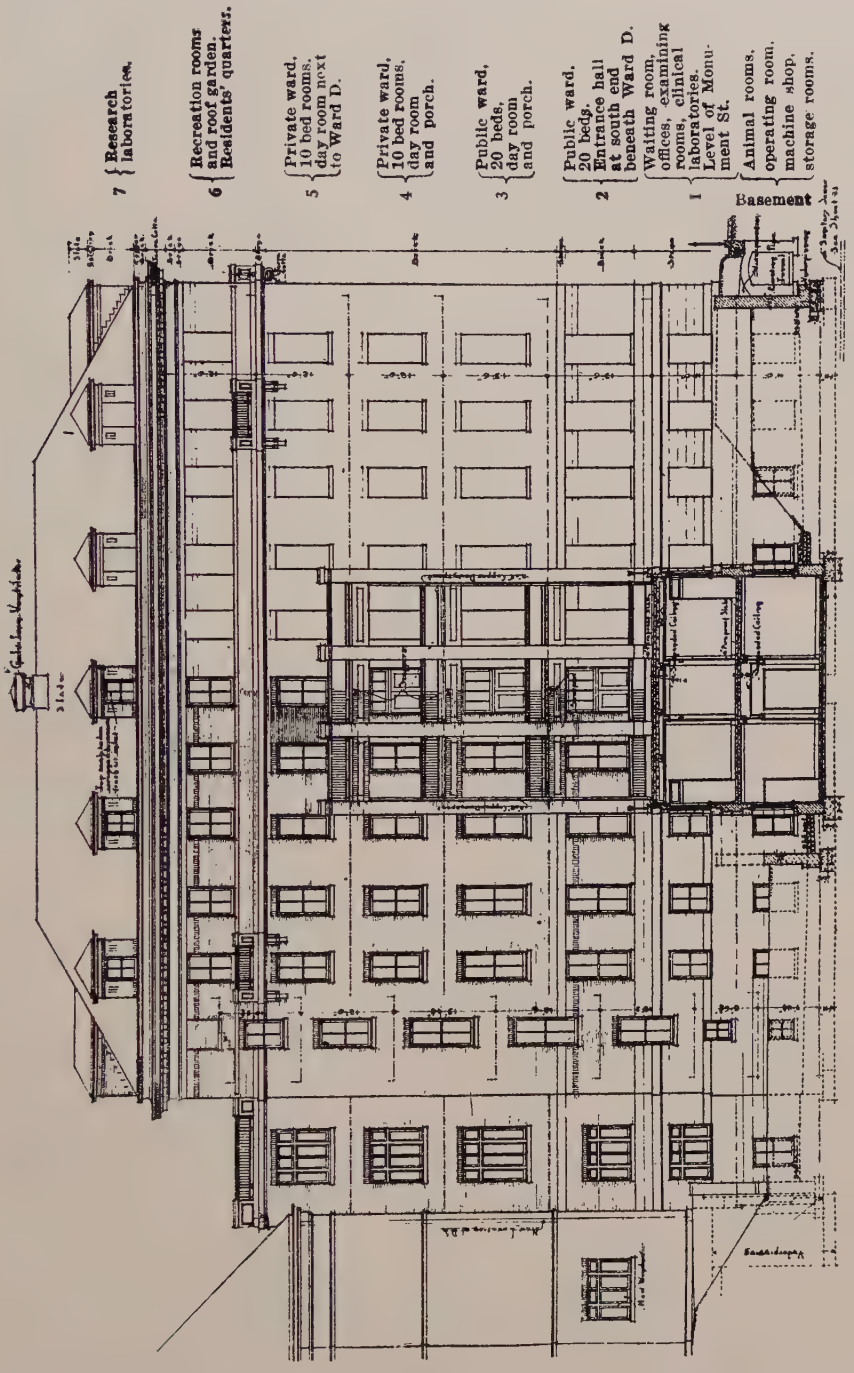

FIG. 995.—The James Buchanan Brady Urological Institute. East elevation, facing surgical building, with sectional view of two-story laboratory building connecting the two buildings.

and advancement in the field of urology and borderline subjects. The accompanying illustrations of some of the plans show the fruition of our labors.

The building consists of eight stories, with a basement (Fig. 995). The loca-

tion was determined by a desire to be adjacentto and connect with the "urological out-patient dispensary" in the first floor of the surgical building.

FIG. 996.—The James Buchanan Brady Urological Institute. First floor, showing connection with urologic out-patient dispensary in surgical building, which had been remodeled. In this floor of the Brady Institute are concentrated the clinical and laboratory studies on patients, public and private, out-patient and in-patient. Intricate and interesting dispensary cases are brought over for further study. Together they furnish great facilities for clinical work.

The basement contains rooms for animal experimentation. In order that no smell or noise shall get beyond the rooms in which the animals are kept, fresh air is forced in at the ceiling (after passing over steam coils) and then drawn out by

other fans through the registers near the floor. In this way a healthful atmosphere can be maintained without opening the windows. Adequate animal operating and preparation rooms are provided, with apparatus for sterilization, etc.

A well-equipped machine shop is also provided in the basement. This is used in the preparation of experimental apparatus and new surgical instruments. The machinist in charge has been of great service in many of the activities of the institute.

The first floor (Fig. 996) takes care of varied activities. A waiting-room for patients to be admitted to the hospital is found on this floor. Rooms for clinical purposes, history taking, consultation, and examination are amply provided for. There are six rooms for general urologic examinations, including urethroscopy, cystoscopy, and ureter catheterization. Each room is supplied with hot and cold

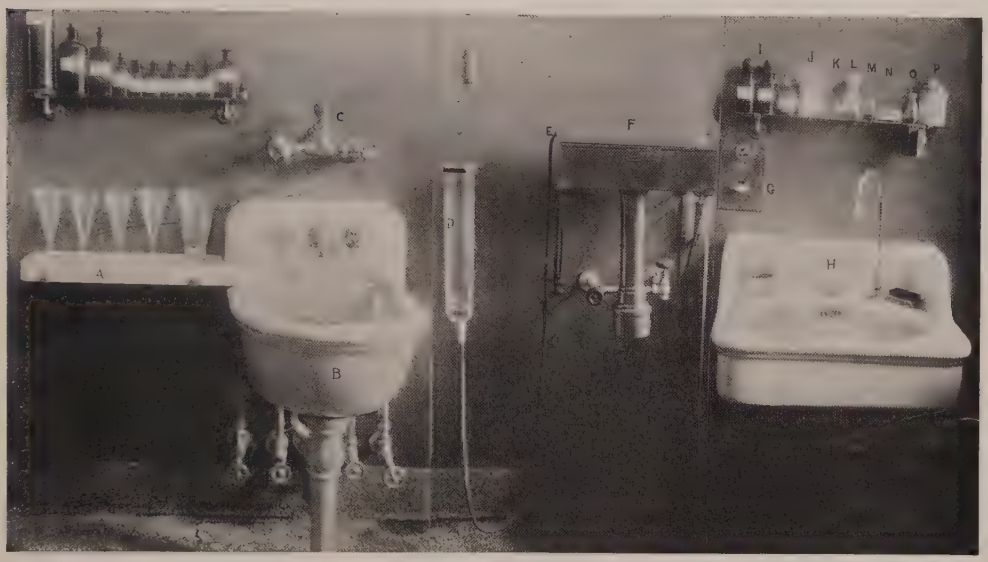

Fig. 997.—Wall unit in treatment rooms of Brady Urological Institute. A, Drainboard with specimen glasses. B, Irrigating sink for standing lavage. C, Hot and cold sterile water. D, Irrigator. E, End of tube and nozzle in electric steam sterilizer F. G, Electric switch, 3 heats. H, Clean-up basin with knee control. I, Double bulb syringes in stock solutions, ½ per cent. mercurochrome and 1 : 500 meroxyl. J, Large cotton pads to cover glans after injections. K, Toothpicks to plug ureter catheters. L, 15 per cent. sodium iodid for pyelograms. M, Liquid paraffin, sterile. N, Rubber finger-cots. O, 4 per cent. novocain, sterile. P, Small cotton pledgets, sterile, to dry cystoscopic lens.

sterile water (provided from a general system) for the preparation of irrigations, an electric sterilizer for instruments and nozzles, sink lavatory, etc. An excellent idea of the arrangement of the wall fixtures and equipment is given by Fig. 997. As seen here, a marble drain board has several beakers in which the patient may void urine in three glasses for microscopic study. Over the porcelain irrigating sink is seen a faucet where hot or cold sterile water may be obtained for the preparation of irrigating solutions, with the addition of drugs taken from the bottled solutions on the glass shelf. The irrigating percolator hangs suspended from the ceiling. The extreme end of the rubber tube, with the nozzle attached, lies within the electric sterilizer ready for aseptic use. Catheters, instruments, etc., may be boiled in the same sterilizer. To the extreme right is a wash-up basin with knee control. The glass shelf above contains lubricants and 4 per cent. procain in sterile bottles, sterile swabs and cotton sponges, solutions of mercurochrome

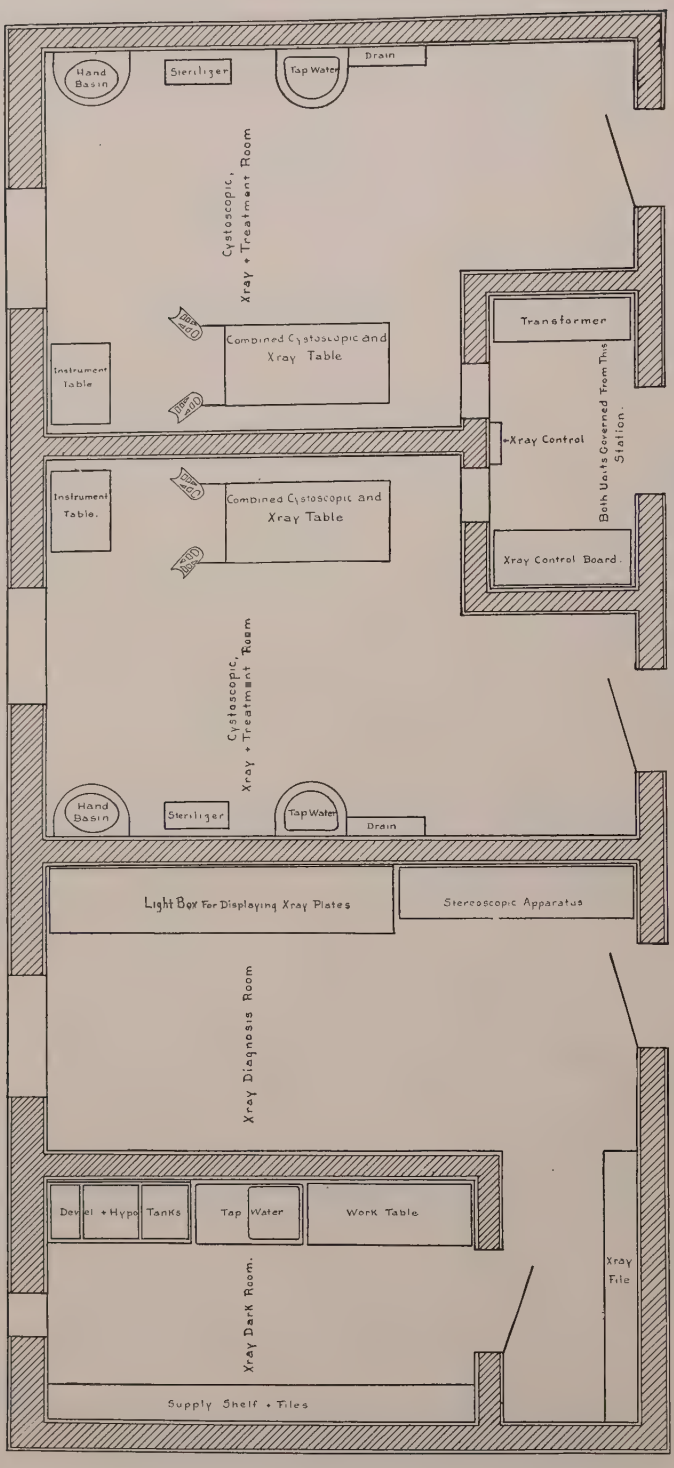

FIG. 998.—Plan for combined cystoscopic and *x*-ray rooms. Modified slightly from rooms in use at Brady Urological Institute.

½ per cent. and meroxyl 1 : 500 in bottles, with bulb syringes immersed, for immediate use. This urologic wall unit has been evolved after considerable experi-

mentation and furnishes a very complete and handy outfit for thorough and rapid urologic work. On the opposite side of the room is a cystoscopic table with fixtures on the wall for alternating and direct current, transformers, high-frequency apparatus, negative pressure tubes for vacuum work, etc.

Two of these rooms are adjacent to *x*-ray apparatus, so that radiographs, pyelograms, stereoscopic films, etc., can be taken without moving the patient from the cystoscopic table. The actual floor plan and arrangements for combined roentgenology and cystoscopy are shown in Fig. 996. An improvement over our present arrangement is offered in the more detailed plan, as shown in Fig. 998. We cannot too greatly stress the importance of such facilities for the combined work of the urologist and roentgenologist, not only for the sake of the patients, but to save time and trouble for everyone. For the expeditious carrying out of this tedious work, it is absolutely essential that the best possible facilities to permit thoroughness and to avoid loss of time be afforded in this combined study of urinary diseases. For this purpose a combined cystoscopic and *x*-ray table is absolutely essential. Since the introduction of our first model in 1915 various adaptations and modifications of our table have been brought out elsewhere and also in our own workshops. Our latest table, which is provided with a flat Bucky diaphragm beneath a non-metallic, non-corrosive bakelite top, and an *x*-ray standard by means of which the tube can be quickly brought—without adjustment—into the focus of the diaphragm, whether in a horizontal, vertical, or inverted position, is a great improvement over the early models in which a sliding tube stand attached to the side of the table was used. To be able to take stereoscopic shadowgraph pictures of all portions of the urinary and seminal tracts in various positions of the patient has made radiographic urology far more accurate and valuable to the urologist.

Specimens for urinalysis or histologic diagnosis may be studied in the adjacent laboratories; *x*-ray plates are developed and studied in rooms provided for this purpose. Laboratories for bacteriology, pathology, and chemistry, and rooms for private research are provided. These, taken in conjunction with the rooms for animal experimentation in the basement, offer good opportunities for investigation. The various laboratory rooms are equipped with vacuum and compressed air. Running water and small staining sinks on the microscopic tables add to the convenience of the workers.

Figure 996 shows how well this laboratory floor ties in with the urologic out-patient dispensary, which is very commodious and well adapted for a large out-patient clinic. The general clinic room holds six operating tables, besides two places for standing irrigations, sterilizing apparatus, etc. Adjacent is a clinical laboratory in which urinalysis, bacteriologic work, and study for spirochetes are made. Another room provides a place for minor operations, and next comes a room for urethroscopy and cystoscopy. A lecture room and a small teaching museum complete the floor, which connects with the two-story wing of the Brady Institute.

Important and interesting cases, discovered in the out-patient department, are brought over and thoroughly worked up in the examining rooms and laboratories of the Institute, and, if necessary, ureter catheterization, functional renal tests, radiographs, pyelograms, etc., are carried out, before or after admission to the hospital wards.

The hospital residents and a selected group of outside workers are used in the various departments at different times of the day, viz., dispensary, laboratories, research rooms, animal experimentation, hospital examinations, and treatments on public and private patients, work in the operating room and in the wards. This concentration of various activities does much to save time, facilitates thorough work, brings all the workers into close touch with each other, inspires a spirit for experiment and research, and insures a full utilization of all the clinical material at hand. Whole-time laboratory men are present to lead in research and experimental work.

The second floor contains a public ward for 20 patients, subdivided into a large ward for 12 patients, two single bed wards for special cases, and two small wards of three beds each. The service rooms are grouped at the center of the building, thus facilitating administration. The provision of both utility and charting rooms and a special room for the orderlies' work are novel features. The food lift is reached from the outside of the building on this floor by a bridge from the kitchen, thus doing away with the necessity of bringing the food trucks into the building.

An office for the supervising nurse of the building is next to the entrance lobby—a convenient point for administrative purposes.

The third story is similar to the second—a public ward for 20 patients. Over the entrance hall of the floor below there is an attractive day room.

The fourth and fifth stories each contain rooms for private patients. Every room is provided with a lavatory and running hot and cold water—a great convenience to patients, nurses, and doctors.

The corridor floors, both in the private and public wards, are of battleship linoleum with a broad border of gray marble, and a coved marble base. In the laboratories terrazzo is used, and also in the examining rooms. In two of these latter rooms in which *x*-ray work is done, a covering of sheet rubber has been employed to minimize danger of electric shock, and also for comfort. The private bedrooms have wood floors of Georgia pine.

The sixth floor is primarily for residents' quarters. The chief resident has his study, bedroom, and private bath; the others each a bedroom with lavatory and running water, and the use of a conjoint sitting room. The rest of this floor is used as a daytime sitting and lounging place for private patients, a large day room, an open porch or "loggia," and a deck or roof garden being provided.

The seventh floor is arranged to provide laboratories for research. It is generally agreed that these should be separate from the clinical laboratories, and the top story thus provides an ideal place for this purpose. Good overhead light is obtained with skylights. The west side is equipped for chemical work; three well-arranged laboratories with every convenience for chemical work are provided. The other rooms are used for research work in pathology, bacteriology, physiology, physics, and borderline subjects between medicine and urology. One room of this floor is devoted to the preparation of models—anatomic, pathologic, clinical, and operative—by a special sculptor in charge.

No operating rooms for patients are provided, as ample accommodations are present in the surgical building. The building is of modern fireproof construction.

Organization.—As such hospital units are comparatively new, a few words on the organization and plan of operation may be of interest. The staff is twofold.

I. Clinical

Director and visiting urologist.
Assistant director and visiting urologist.
Chief of dispensary.
Two dispensary assistants.
Resident urologist.
Two assistant resident urologists.
Four interns.
Five post graduate students.

II. Research

Whole-time department heads in:

1. Microscopy, bacteriology, and immunology.
2. Clinical pathology.
3. Chemistry.
4. Roentgenology.
5. Experimental surgery.
6. Graphic art (medical illustrations).
7. Plastic art (models).

The Clinical Organization.—This, like the research staff, is practically a whole time organization in that ample room and facilities are given for the reception and examination of private patients, and the director therefore finds it unnecessary to have private offices, and spends his entire day from 9 A. M. to 5 P. M. at the institute. A fixed charge is made for the use of cystoscopic rooms, etc., for his private patients, so that a fair revenue accrues to the maintenance fund. This arrangement is advantageous to the hospital and makes it possible to keep practically all the clinical staff busy at the institute the entire day (without cost to the hospital and university for salaries for the clinical men).

The organization of the Brady Urological Institute recognizes the great advantage to the hospital and university of furnishing adequate facilities for the examination and treatment of both public and private patients (from whom proper compensation is received by the hospital), so that the clinician is delighted to devote his entire time to the institution where his teaching, his clinical, experimental, and research work are located.

The routine work has been subdivided as follows: (*a*) Three mornings in the operating room—Monday, Wednesday, and Friday, 10 to 1 o'clock; (*b*) three mornings in a diagnostic clinic in the institute; (*c*) every afternoon, 2 to 4 o'clock, in the out-patient dispensary; (*d*) ward work every morning, 9 to 10 o'clock, for interns; (*e*) three to four hours free every day for interns, in which they are expected and urged to engage in research.

Our object has been to vary the work of interns from week to week, and to provide at least three hours each day during which they shall not be engrossed in routine work, but may have time for research. This is accomplished by having only half of the staff in the operating room, in the diagnostic clinic, or in the dispensary at a time, and by varying the assignments so that each man is free from one of these assignments each day (if not morning, then afternoon).

As the resident and assistant resident urologists are all men who have had at least two years, previous training and operative experience in general surgery, leisure for research is most important for them.

The five postgraduates, who are also chosen with reference to their surgical training, and who remain one or more years, are utilized as assistants, and have their work varied from week to week as much as possible. They are also encouraged to engage in clinical or laboratory research.

The clinic is in direct charge of the first assistant, who sees that all runs smoothly, that good histories are taken and typewritten at once, that proper preliminary

examinations are made, and the patient assigned to the appropriate room for thorough examination. The proximity of the laboratories, and the ability to take radiographs or even stereoscopic pyelograms upon the cystoscopic tables, facilitates the work greatly.

In the triweekly diagnostic clinic, the clinical staff is occupied from 10 to 1 o'clock on Tuesday, Thursday, and Saturday. Heads of the research staff, the artists, or the photographer are called in when specially interesting cases or problems appear. This clinic takes care of all private cases arriving for diagnosis, treatment or operation, interesting dispensary cases requiring further study, and cases from the public and private wards.

The various assignments given interns and postgraduates furnish varying experience both with the public and private cases.

The out-patient dispensary is also run largely by interns and postgraduates who act as special instructors for undergraduate students under the supervision of the chief and two assistants, who likewise devote nearly all of every day to the hospital. The histories are all typewritten and the stenographer is required to get a daily note on each patient. The out-patient clinic being in intimate contact with the Urological Institute, close co-operation is obtained—a great desideratum.

The research departments are presided over by whole-time salaried men of experience. They offer special courses for small groups of students, direct their special laboratories, and engage in research. As many problems overlap, these laboratories are co-operative and mutually helpful. The animal department is utilized by all, as is also the machine shop.

Our object has been to give a clear understanding of the scope of this special surgical unit in a general hospital with the hope of showing the importance of concentration of all activities in one building, adequate equipment for all clinical work both public and private, out-patient and in-patient, with a close proximity of laboratories, manned by competent heads, so that every worker has ample opportunity for and should be inspired to engage in investigation and research. Our hope has been, indeed, to make Mr. Brady's foundation truly a research institute of Urology.

Undergraduate Teaching.—With the rapid development of medical science and art in every direction the undergraduate student has been veritably swamped with learning to be acquired. When one of us "ancient interns" (as they are called in Paris) stops to consider how many times the medical curriculum has been multiplied since our student days we realize at once the danger of overcrowding students with too many details of the specialties of modern medicine. Here we make no effort to give detailed instruction to undergraduate medical students, nor to make them expert in urologic technic. If we can sufficiently instruct them in the fundamentals which are of utmost importance to a good knowledge of medicine and surgery, we have accomplished enough. If, at the same time, we can inspire them with the importance and beauty of the subject, some will be likely to return, demanding to be initiated into the intricacies of the art.

Working on this basis, the undergraduate is given instruction for a trimester as a student assistant in the out-patient dispensary. Weekly clinical lectures and quizzes on cases coming to this out-patient clinic are held, and ward rounds for an hour once a week for every student in the surgical group during each trimester are given. At these ward rounds the usual methods are employed, stress being

laid upon the importance of careful manual examination and delineation by free-hand drawings or diagrams of the findings. Dr. Osler's apt remark that "the difference between the good doctor and the poor one is that the good doctor knows how to make a rectal examination" is often quoted, and the student is urged to make careful charts of the rectal examination of all the cases which he meets in the various hospital wards. In urologic ward rounds we stress the importance of careful study of the history, the pathology, etiology and complications, the indirect

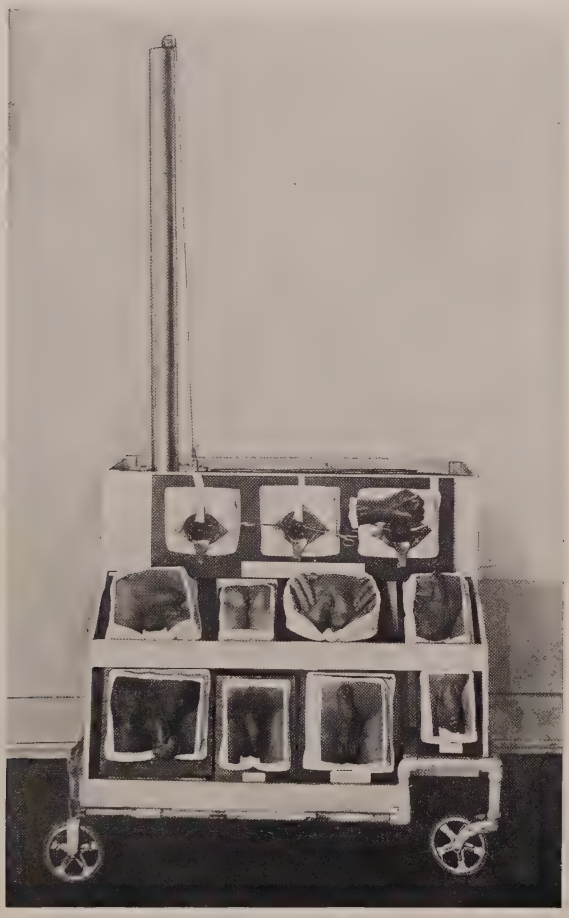

FIG. 999.—The "urologic bus," stocked with specially chosen models on this side and pathologic specimens on the other, ready to transport to a ward for rounds with the class. The charts are carried within the central portion, being suspended by a wire, and balanced by a lead weight inside the vertical tube.

diagnostic methods which have been used in working up the case, and the surgical technic which is to be employed.

Long convinced of the lasting value to students of ocular demonstrations, we have prepared methods by which in every possible way the various problems presented by each case may be shown. For this purpose we have developed what is called the "urologic bus." This vehicle, which is shown in Figs. 999 and 1000, consists of a carriage which is sufficiently small to be taken along on teaching rounds. It is provided with shelves on each side on which are placed anatomic and pathologic models or specimens, etc., which have previously been selected in accord-

ance with the cases and diseases to be seen at ward rounds. The interior of the "bus" contains a series of photographs mounted on large cards, inserted into frames which hang by a cord from a pulley, being counterbalanced by a lead weight. When withdrawn from the central compartment the proper pictures may be brought to view by spreading the fan-like group of metal frames containing them (Fig. 1000).

A typical case upon which rounds were recently held may be cited. The patient was one with stone in a double kidney on the left side. The student gave a com-

FIG. 1000.—"Urologic bus" opened out at ward rounds for clinical lecture on patient with tumor of the kidney. Specimens of tumors removed from other cases are to be seen in the jars. The charts are opened out to demonstrate the embryology and pathology of these cases. This bus follows the lecturer from bed to bed, and is used for demonstrating the conditions present, the operative treatment contemplated, the specimens removed from previous cases, etc.

plete history and described the clinical and laboratory findings. The simple *x*-ray plate showing a stone high up in the left renal region was exhibited, and the pyelogram which showed that the kidney was double, the lower half containing no stone and secreting healthy urine. The case was further elucidated by showing a chart carried in the "bus" depicting cystoscopy, ureter catheterization, and the taking of a pyelogram, on the combined urologic and *x*-ray table; a card containing drawings explaining the embryology of the kidney and the development of double kidney and bifid ureters; a card showing the operative technic of extraperitoneal

exposure of the kidney and the operation of heminephrectomy for double kidney and bifid pelvis; the specimen (from the shelf of the "bus") removed at operation and other specimens from other operations and from autopsy cases.

The convalescence was then described; the phthalein before and after operation presented, with charts showing curves of elimination; and finally the healing wound was exhibited.

By such a presentation the students obtain not only the usual history and description of diagnostic methods, but also full and complete ocular demonstrations of the pathology, embryology, and surgery of the case, so that (in our opinion) a much more lasting and complete impression of the case is engraved upon the student's mind.

In these rounds we also make use of series of drawings by Mr. Didusch, as well as models which have been prepared by Dr. Fortunato. At our suggestion Dr. Franklin P. Johnson has published an interesting article describing the use of models in the teaching of urologic surgery[1]:

> The value of models as an aid to the teaching of anatomy and embryology has long been recognized, and we are all more or less familiar with the commercial products of Ziegler's, Trammond's, Rouppert's, and Ward's laboratories. In addition to these one sees in almost every anatomic laboratory numerous homemade models usually constructed after the Born wax plate method. These are of great aid to the student in helping him to visualize and fix in his mind complicated anatomic structures and the intricate developmental processes. In courses in pathology models are used to some extent, but an increase in their use would certainly result in benefit to the student. The beautiful and carefully made dermatologic models in the Army Medical Museum clearly demonstrate the value of models in this branch of medicine.
>
> However, in this country practically no attention has been paid to the application of this method in the teaching of operative surgery. To demonstrate an operation, the surgeon has relied upon diagrams, drawings which are often distorted, and photographs which are usually none too clear. Stereoscopic photographs have been used with some success and more recently motion pictures have been tried. All of these are valuable methods but they cannot compare with a graded series of models showing the operation step by step, for in carefully made wax models, size, shape, and color can be shown without exaggeration or distortion, and what is equally important, things are shown in their three dimensions. Moreover models can be handed from one student to another and the details studied minutely at leisure.
>
> It was because of the student's difficulties that Dr. Hugh H. Young suggested to me the preparation of a series of models showing a perineal prostatectomy. The operation which is shown in the accompanying figures is an imitation of that performed by Dr. Young routinely at the Johns Hopkins Hospital. The actual modeling has been done by Dr. V. Fortunato, who has developed a technic by which he can prepare models which are as true to life as it would seem possible to make them. His models comprise faithfulness of reproduction in form, color, and texture as well as durability; they must be seen to be appreciated.
>
> Briefly the method of preparation of the models can be stated as follows: The portion of the surface of the body to be modeled is shaved and coated with a thin film of mineral oil. A thick layer of dental plaster of Paris, properly mixed with water, is then carefully spread over the part. The plaster is allowed to harden and the mold, a negative, is lifted off. After the mold has been allowed to dry at room temperature for two or three days, it is then soaked in cold water until it is thoroughly saturated. Any excess water is sponged from the surface with absorbent cotton, and the mold is immediately filled with melted wax. The formula of the composition used by Fortunato I am unable to give, as this he holds in secrecy. Unlike wax, the composition after thoroughly hardening is durable and not easily indented or broken.
>
> For the preparation of the models shown in this paper a suitable cadaver was secured through the kindness of Dr. Lewis A. Weed of the anatomical department of the Johns Hopkins Medical School. As the operation progressed, it was stopped at various points and plaster impressions

[1] Surgery, Gynecology, and Obstetrics, 1924, xxxix, 682–687.

FIG. 1001.—Drawing by Didusch of models by Fortunato of Young's perineal prostatectomy. Model 3 showing urethrotomy at apex of prostate upon sound in urethra. These models are in natural colors and practically indestructible.

FIG. 1002.—Same at later stage. Lateral lobes partly enucleated, verumontanum seen in lower flap.

taken. Retractors and other instruments used were held by assistants as in the operation on the living subject. From these molds the models were cast. Details of structure, and the color and texture of the various tissues were carefully studied in the operating room and were added later. The retractors were made of composition and covered with a thin layer of metal foil. Models of the gloved hand shown in the figures were made separately. In all, twelve models were made. These were mounted on specially prepared boards painted black, three models to each board. Draperies, saturated with a chalk-like paste to insure their permanency, were added last.

Figures 1001 to 1003 show graphically the wonderful realism of Dr. Fortunato's models which he and Dr. Johnson prepared to demonstrate the operation of per-

FIG. 1003.—Same at later stage. Prostatic hypertrophied lobes enucleated in one piece around shaft of instrument. Vesical sphincter visible and intact.

ineal prostatectomy. Of even greater value are the models of anomalies and deformities and pathologic lesions, of which we have collected a long series, some of them being cases of great rarity of the kind which are seen only once in many years. These are preserved for the inspection of each group of students and furnish almost as valuable clinical pictures as the original patient.

Dr. Johnson concludes his article as follows:

The teaching value of the models herein described has already been demonstrated. They lend themselves equally well to individual or group teaching. They give to the student a better idea of the operation than he could obtain in the operating room for, at his leisure, he can study all details without missing a single step.

Not only is modeling of value in surgery from the standpoint of showing operations, but the method can be used for other purposes as well. Tumors, ulcers, malformations, etc., if they present themselves externally, are simple to reproduce in wax. The method is excellent for recording the results in plastic surgery, for impressions can be taken before and after the several stages of operations of this kind. It was in this connection that the author became interested in modeling. A number of cases of hypospadias and other malformations of the external genitalia were modeled before and after operation and thus accurate records of the results obtained are made available.

These models of hypospadias, etc., are now serving as a nucleus for a much larger teaching collection, which is being constantly added to at the Brady Urological Institute. It is proposed by Dr. Young to have in the collection not only models showing pathologic lesions and deformities, but a series of models such as is shown in this paper of all the important operations in urologic surgery. At this time a second series of models showing Young's radical operation for carcinoma of the prostate is nearing completion.

I hope I have demonstrated that this method is as applicable to the teaching of surgery as it is to anatomy and embryology. I do not mean to imply that models of operations should supplant the surgical clinics, but used judiciously in conjunction with them they should prove a great help to the student.

In the foregoing description of the organization, equipment, and use of the Brady Urological Institute we have endeavored to set forth the problem of the study and teaching of urology as we have encountered it, so that those who are interested in similar developments may be able to make use of our experience and be warned by our failures.[1]

With the passage of years urology has rapidly come into its proper place as one of the most important branches of the hospital and medical school, and the surgical work connected with it is now recognized as sufficiently intricate and difficult to require the highest skill. No branch of medicine presents a more interesting field for research and experimentation, and with the organization of similar institutes and special departments connected with great hospitals and medical schools, urology is now on the way to greater advances and to further justification of our pride in what we consider one of the most scientific branches of medicine.

[1] See also Young, The Renaissance of Urology, Southern Medical Journal, 1916, ix, 146–153, from which extracts have been made in this chapter.

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